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TRENDS IN U.S. LIFE EXPECTANCY

HEARING

BEFORE THE

SUBCOMMITTEE ON SAVINGS, PENSIONS, AND INVESTMENT POLICY

OF THE

COMMITTEE ON FINANCE
UNITED STATES SENATE

NINETY-EIGHTH CONGRESS

FIRST SESSION

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TRENDS IN U.S. LIFE EXPECTANCY

FRIDAY, JULY 15, 1983

U.S. SENATE,
COMMITTEE ON FINANCE SUBCOMMITTEE ON SAVINGS,
PENSIONS AND INVESTMENT POLICY,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:35 a.m., in room SD–215, Dirksen Senate Office Building, Hon. John H. Chafee (chairman of the subcommittee) presiding.

[The committee press release announcing the hearing and the opening statements of Senators Chafee and Dole follow:]

FINANCE SUBCOMMITTEE ON SAVINGS, PENSIONS, AND INVESTMENT POLICY SETS HEARING ON TRENDS IN U.S. LIFE EXPECTANCY

Senator John H. Chafee (R., R.I.), Chairman of the Subcommittee on Savings, Pensions, and Investment Policy of the Senate Committee on Finance, announced today that on Friday, July 15, 1983, the Subcommittee will hold a hearing on trends in the projected life expectancy of U.S. citizens and the potential effect of these trends on retirement planning and other economic and social policies.

The hearing will begin at 9:30 a.m. in Room SD–215 of the Dirksen Senate Office Building.

In announcing the hearing, Senator Chafee stated that, "Our first area of interest is to identify whether current life expectancy projections are accurate, or whether Government policymakers and other projections underestimate the number of people who will live well beyond 65.

"Another intriguing question is the likely limit on the human life span in the 21st century," the Senator added. "Advances in science and medicine, especially in the treatment of major diseases such as heart disease may have increased life expectancy to its current level, but the extent to which these advances can continue to promote increased longevity is unclear."

Senator Chafee also noted that the answers to the question of increased longevity would have a significant impact on retirement policies, economic planning, and individual lifestyles. He added that while the Subcommittee cannot expect to examine these issues in detail at this hearing, he hoped that the Subcommittee could begin to identify the issues that should be considered in light of a projected increase in U.S. life expectancy.

"The prospect of increased U.S. life expectancy presents an opportunity and a challenge," the Senator concluded. "It is exciting to consider that advancements in science may have added years to the lives of U.S. citizens. But it is important that the Government and the private sector act now to understand the impact of these additional years. Employers, employees and their representatives must have this information in order to plan for the future. In this way the quality, as well as the length, of our lives can be improved."

Senator Chafee stated that testimony at this hearing would be received from invited witnesses only. A list of witnesses will be announced at a later date.

REMARKS OF SENATOR JOHN H. CHAFEE

We live in exciting times, but demographically, these may be the most exciting times in our history. Unprecedented gains have been made in life expectancy and these gains will likely continue, possibly even accelerate. At the same time we are

expanding our understanding of the processes of aging in ways that may lead to the extension of life span itself.

These developments hold both great opportunity and great challenge.

The opportunity is, of course, that many of us can expect to live longer, fuller lives. The challenge for us as individuals is whether we can enjoy these additional years as vital, productive members of society. The challenge for society is whether we can adapt family structures, social and government institutions to the fact that so many of us will be old. And ultimately, we must ask, how will we be able to afford the support of an elderly population numbering as many as one-fifth of the total population.

These concerns can quickly be demonstrated by numbers which illustrate the advance of life expectency. In 1900, 3.1 million people, or 4.1 percent of the population lived to be 65 and over. In 1980, 26 million, or 11.3 percent of the population, reached this age. By 2000, 36 million people or 13 percent, and by 2025, 58 million or 20 percent of the population is projected to live to be 65 and over.

The startling fact is that these huge increases in Americans' life expectancy will be accomplished even without our having found cures for the major chronic diseases.

The increase in life expectancy is only one aspect of the issue. Life span extension must now also be considered. Man has never is his history lived much beyond 110. (The oldest verified individual lived to be 114.) But this age-old fact is now being challenged. As one of our witnesses, Dr. Walford, has suggested, life span could be increased by 40 or more years. Such speculation might be dismissed out of hand. Yet we really cannot afford to blind ourselves foolishly to the fiscal and societal effects of such a leap of scientific knowledge.

The combination both of continued increases in life expectancy and the possibility of increases in life span are simply staggering from the standpoint of public policy.

Very clearly, the assumptions that government and private actuaries make about mortality rates are critical in projecting future federal outlays. For example, the total federal benefits that would have been paid to people had they not died in 1978 of heart diseases, cancer, car accidents and homicides would have exceeed the potential taxes the survivors could have been expected to pay by $15 billion. In other words, cures of these killers would have resulted in a net drain of $15 billion, in 1978 dollars.

Facts like these only begin to illustrate the need to have the most accurate possible estimates of mortality. There are 51 federal retirement programs encompassed in 38 separate retirement systems. In 1978 the General Accounting Office expressed its concern that these programs operated separately in the absence of federal guidelines, without uniform practices governing their financing. That concern is as real today as then. As of 1981 only one of the federal retirement systems, the Civil Service Retirement System, assumed that mortality rates would improve in the future. The Federal Reserve uses annuity tables from 1951 when life expectancy for people over 65 was 15 percent less than now.

The Social Security system, the major source of financial security for so many millions of Americans, is of course of special importance. While not strictly speaking a federal retirement program because it insures mainly private citizens, the federal stake in it is enormous.

The Social Security Administration has rather recently adopted a set of three assumptions about mortality—high, intermediate and low. All of them project mortality improvements at rates less than the historical average for the first 80 years of this century. If the low (or optimistic) mortality forecast were accurate, there could be 15 percent more Social Security beneficiaries by 2020 than the intermediate estimate would indicate.

The Social Security Administration's intermediate projection assumes an improvement in mortality of 37 percent over the next 80 year period, whereas it improved 67 percent over the previous 80 years.

We are all, I am sure, interested, even fascinated by the possibilities that exist for increased life expectancy and life span. But the central issue of concern today is whether or not federal and private retirement systems—and other programs based on actuarial estimates of mortality—are taking into account these possibilities. Projections of mortality based solely on historical date are in danger of being wrong. It is quite sensible to expect that medical science will continue to make substantial progress against the major causes of death. Retirement systems that are based on mortality estimates that do not attempt to encompass these possibilities are, in my view, potentially at risk.

I hope that today we will shed light on these issues.

THE "RECTANGULARIZATION" OF LONGEVITY

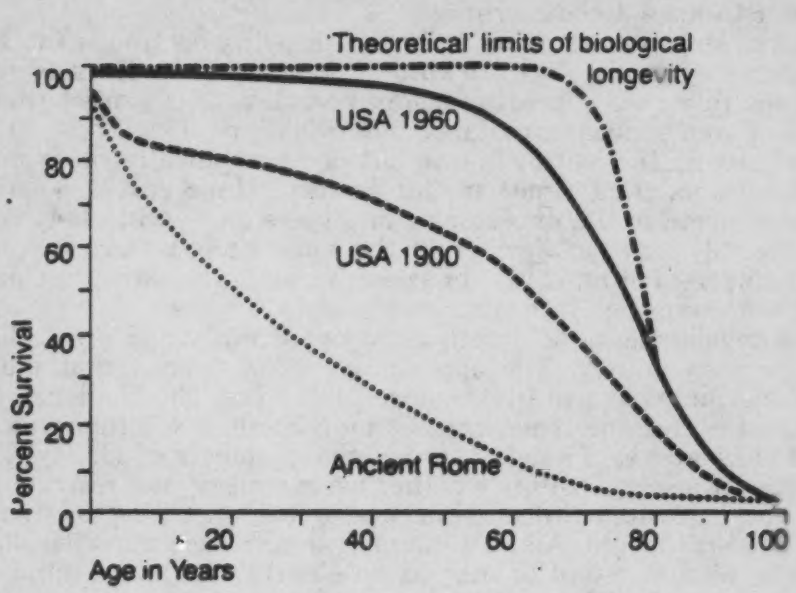

TABLE 1

	1900	1940	1975	1980
Percent of the population age 65+ and 80+; United States:				
Total 65+	4.1	6.9	10.5	11.3
Total 80+	0.6	0.9	2.1	2.3
Percent of deaths age 65+ and 80+; United States:				
Total 65+	24.3	45.8	64.3	67.2
Total 80+	7.3	14.1	27.8	30.6

Source: National Center for Health Statistics.

Statement of Senator Dole

I am pleased to welcome you to these hearings on life expectancy trends in the United States.

I do not believe there is any disagreement with the projection that the population over age 65 will increase dramatically in the next 50 years. This trend is of great interest to us as lawmakers and as members of the Finance Committee, since we must work to insure that our political and economic system prepares for an increase in the proportion of older Americans. We must also anticipate necessary social and attitudinal changes with respect to the role of older individuals in our society.

But before concrete planning can begin, it is necessary to focus on the magnitude of the changes that are being forecast. Both lawmakers and policy planners in the private sector have come to depend on a number of institutions to provide statistics and information that, quite frankly, we sometimes don't fully understand and are tempted to accept at face value. It is sometimes necessary to take a close, hard look at the numbers, percentages, and charts we receive, and to reflect on the assumptions underlying those numbers and the policy implications of interpretating those numbers in a particular manner. I hope that these hearings will provide us with information to make these evaluations.

Finally, I would like to emphasize that these projected trends in life expectancy should not be seen as a message of impending economic or social doom. Rather, it is

exciting to contemplate that advances in medical technology and health planning have resulted in an increase in life expectancy, and I look forward to learning about what trends may be in store for us in the future.

Senator CHAFEE. Good morning.

This morning we are going to have a hearing on trends in U.S. life expectancy, and I look forward to hearing the witnesses. We have some fine ones appearing before us today, on a subject that I think is of tremendous importance to our Nation.

We are living in exciting times, but demographically these may be the most exciting times in our history. Unprecedented gains have been made in life expectancy, and these gains will likely continue, possibly even accelerate. At the same time, we are expanding our understanding of the processes of aging in ways that may lead to the extension of lifespan itself.

These developments hold both great opportunity and great challenge for our country. The opportunity is, of course, that many Americans can expect to live longer, fuller lives. The challenge for the United States and Americans as individuals is whether we can enjoy additional years as vital, productive members of society. The challenge for society itself is whether we can adapt and restructure social and governmental institutions to the fact that so many Americans will be old. And ultimately, we must ask ourselves how we will be able to afford to support an elderly population numbering as much as one-fifth of the total population.

These concerns can easily be demonstrated by numbers which illustrate the advance of life expectancy. In 1900, three million people, or four percent of the population of the United States lived to be over 65. By 1980, 26 million people or 11 percent reached this age. By the year 2,000, 36 million people or 13 percent of the population will live beyond 65, and by the year 2,025—and that is not so far away—58 million or 20 percent of the population is projected to live to be over 65.

These huge increases in the life expectancy of Americans will be accomplished even without our having found cures for the major chronic diseases.

The increase in life expectancy is only one aspect of the issue. Lifespan extension must also be considered. Man has never in history lived much beyond 110 years of age, but this fact is now being challenged. One of our witnesses, Dr. Walford, has suggested that lifespan could be increased by 40 or more years.

Yet we really cannot afford, to blind ourselves foolishly to the fiscal and societal effects of leaps in scientific knowledge. The result both of increases in life expectancy and the possibility of increases in lifespan could be simply staggering from the standpoint of public policy. Very clearly, the assumptions that Government and private actuaries make about mortality rates are critical in projecting the future Federal outlays.

For example, the total Federal benefits that would have been paid to people had they not died in 1978 of heart disease, cancer, automobile accidents and homicides would have exceeded the potential taxes the survivors could have been expected to pay by $15 billion. In other words, cures of these causes of death would have resulted in an added cost of $15 billion in 1978 dollars.

Facts like these only begin to illustrate the need to have the most accurate possible estimates of mortality. There are 51 separate Federal retirement programs encompassed in 38 separate retirement systems. I became aware of this when a judge of the U.S. Court of Tax Appeals, came to see me. He wanted some changes in the Tax Court's pension fund. And mind you, they have a separate pension fund for the Tax Court as well as a separate pension fund for all kinds of organizations in the Federal Government.

These programs operate separately, in the absence of Federal guidelines, without uniform practices governing their finances. But of course, the major program that we are concerned with is the social security system, which is the major source of financial security for so many millions of Americans.

While not strictly speaking a Federal retirement program, because it insures mainly private citizens, the Federal stake in the social security system is enormous.

The Social Security Administration has rather recently adopted a set of three assumptions about mortality: High, intermediate, and low. All of them project mortality improvements at rates less than the historical average for the first 80 years of this century.

If the optimistic mortality forecast were accurate, there could be 15 percent more social security beneficiaries by the year 2020 than the intermediate estimate would indicate. The Social Security Administration's intermediate projection assumes an improvement in mortality by 37 percent over the next 80-year period, whereas mortality improved 67 percent over the previous 80 years.

We are all fascinated, by the possibilities that exist for increased life expectancy and lifespan. But the central issue of concern today is whether or not Federal and private retirement systems and other programs based on actuarial estimates of mortality are adequately taking into account these possibilities.

Projections of mortality based solely on historical data are in danger of being wrong. It is quite sensible to expect that medical science will continue to make substantial progress concerning the major causes of death. Retirement systems that are based on mortality estimates that do not attempt to encompass these possibilities are in my view potentially at risk.

I would like to add a personal footnote to this. How did I get into this? Why are we holding these hearings? We are holding them because I personally began to notice that a lot of Americans were living longer. I do not know what the statistics will show, and we are going to have testimony on that, but this issue reminds me of the question that was asked of the southerner: Do you believe in infant baptism? And he said: Believe in it? Heck, I have seen it.

And I have seen, just by looking around, the increased life expectancy of Americans. I think it behooves us to spend some time considering the implications in light of the host of functions of the Federal Government, especially, of course, the social security system.

We spent, earlier this year, many hours on deciding what to do about the social security system because it was in dire trouble. As I look around I see witnesses who have appeared before us in connection with that. As a result, of the problems with the social security system, a Commission was formed which itself devoted over a year

to the study of the problem. They came forward with recommendations which are supposed to take care of the problem to the year 2000.

I am not so sure. I do not want to sound any alarm bells. I hope everything is fine. But I have a nagging suspicion that we are not taking into account adequately the increased life expectancy of Americans in our projection of the costs of social security.

And with that sober note, we welcome our first witness, Mr. Bayo, who is the Deputy Chief Actuary for Long-Range Projections of the Social Security Administration. Mr. Bayo, you have with you, I understand, Mr. Wilkin.

Now, all the witnesses' statements will go in the record and we have them, so do not worry about that. That is a given. We have seven witnesses. I would ask that each witness limit his or her presentation to 10 minutes. If you want to extrapolate from your testimony or present it any way you wish, but at the end of 10 minutes we will have to bring you to a halt.

So go to it, Mr. Bayo, and we welcome you here.

STATEMENT OF FRANCISCO R. BAYO, DEPUTY CHIEF ACTUARY FOR LONG-RANGE PROJECTIONS, OFFICE OF THE ACTUARY, SOCIAL SECURITY ADMINISTRATION, ACCOMPANIED BY JOHN C. WILKIN, SUPERVISORY ACTUARY FOR DEMOGRAPHIC AND ECONOMIC ANALYSIS

Mr. BAYO. Good morning, Mr. Chairman.

Mr. Wilkin and myself appreciate this opportunity to appear before you to discuss the mortality projections that underlie the long-range cost estimates of the social security program. I am submitting a written statement for the record and at this time I would like to present an oral summary.

There is a significant interest in mortality among different groups. Health planners are interested because they want to know how changes in the mortality pattern will affect life expectancy and longevity, so they can offer better services. Industrial and sales planners are interested in mortality because they would like to know the age and sex distribution of the population in order to better plan their production and marketing. Actuaries also like to know mortality patterns in order to better fund insurance policies and private pension plans. In the Social Security Administration, we believe that mortality is an important element in the planning of the program and in the planning of the financing of that program.

Before describing the projections we use in social security, let me make a few remarks about actuarial assumptions in general and about mortality projections in particular. First, I would say that nobody knows accurately what will happen in the future, particularly when we project 75 years into the future. There are bound to be differences among the different experts. As a matter of fact, there are bound to be conflicting differences among the different experts.

This I think is a normal situation and, I would add, it is a healthy situation because it will convey directly the idea that there is uncertainty about the future. In fact, the Office of the Actuary

in presenting its cost estimates to the Congress has used three different projections, one of high level of mortality, intermediate level of mortality, and low level of mortality.

Mortality assumptions are just one of many assumptions that enter into the preparation of the social security program cost estimates. The various assumptions could be classified broadly into three categories. I will name them: Economic assumptions, programmatic assumptions, and demographic assumptions.

The economic assumptions include the gross national product, productivity, price increases, and unemployment. Generally these are variables that have a significant amount of volatility. That is, they change significantly from year to year, sometimes even from month to month. All these variables affect significantly the cost of social security.

Then second I will mention the programmatic assumptions. These are assumptions that are related to the program itself. For example, the retirement rate or the rate of coverage of working people. These are assumptions that have a lower level of variability and they are subject to slower changes.

Third, I will mention the demographic assumptions. Among them we can include fertility, migration, mortality. These are more stable assumptions. They change slower through time and their swings are narrower.

Among these three demographic assumptions, mortality is the most stable of the three assumptions. So I would say that generally there is no need to rush into changing the program just because there are indications that the trend may be changing. There is ample time in which to look at the possible trend and include it in the projections and recognize it in the program planning.

There is an example of this happening, and it is very important. For the last several years the report has indicated to the Congress that mortality has been increasing faster than previously projected. The Congress did not rush into modification of the program, but instead waited until the 1983 amendments. Then Congress fully recognized the deficit that was being projected and eliminated it through those amendments.

So I would say there is no need to be unduly alarmed now. Recent fast declines in mortality have been analyzed by our office. The results have been incorporated into the cost estimates, and the Congress has been using those cost estimates.

If in the future there should be deviations from our projections, new cost estimates will be prepared and conveyed to the Congress through the Board of Trustees, and ample time will be available, in my opinion, to consider possible modification either in the financing of the program or in the structure of benefits in the program.

Let me now turn to how we develop our mortality assumptions. For close to half a century, the Office of the Actuary has been analyzing mortality data. Since 1938 we have been periodically projecting mortality and population as needed for our cost estimates. Since the mid-1970's, we have been preparing annual reviews of the mortality projections, and if needed, revising those projections. Those projections are incorporated into the annual report to the Board of Trustees.

In addition, the Board of Trustees also shows three projections, as I indicated before. Besides that, we also indicate the sensitivity of the cost estimates to variations in mortality.

The data that we have back to the turn of the century shows that mortality declines have varied and that we should therefore, in my opinion, expect that in the future there will be variations in the rate of decline. I would mention four different periods of decline:

From 1900 to around 1937, the decline was about 0.9 percent per year, slightly less than 1 percent per year. This period was a period of wide variation in mortality because of different epidemics.

The second period is 1937 to 1954. Mortality decreased faster in that period, about 2.3 percent per year. It was a steady decline, mostly due to new antibiotics and better public health services.

Then there came a period, from 1954 to 1968, in which mortality remained almost flat. It declined by only 0.1 percent per year. In reality, the death rate for males actually went up. During that period it was felt that future declines in mortality would be difficult to achieve because most of the controllable diseases were already controlled and the remaining diseases generally referred to as the degenerative diseases, were very difficult to control.

However, recent declines since 1968 have shown that improvement can be made in that area, too. Since 1968, we have been having declines of about 1.8 percent per year. This has been a decline related in large part to diseases of the heart and of the blood vessels.

These recent changes, have affected the cost of the social security program. It is easy to understand that as mortality at the older ages decreases significantly, then the cost of the program goes up because there are more older people to whom you have to pay benefits. If the declines were at the younger ages, the effect would be the reverse that is, one of reduction in the cost of the program because we would have realtively more workers.

If mortality changes at all ages uniformly, then the results on the costs of the program are mixed. It could be a slight increase or it could be a slight decrease in costs.

I would say that analysis of past experience is not enough for making the projections. We also need to factor in our views on future developments regarding possible new diagnoses, new surgical techniques, environmental pollutants, exercise and nutritional practices of our population, smoking and drug abuse, including the abuse of alcohol. These are factors that need to be included.

It is very difficult to take these factors into account, particularly since future declines in mortality will be different from those that occurred in the past. For example, the improvements in mortality that we had from the 1930's to the early 1950's due to the control of the communicable diseases cannot be obtained a second time in the future. We have to make progress in other types of causes of death.

For the near future, in establishing our assumptions we can be guided by the near past, and we do that. But the long-range future is mostly unknown, and so we really have to use our imagination as to what are the possible improvements that could be made.

In the midst of all of this uncertainty about future mortality, what we do in our office is postulate ultimate rates of decline and accept that other experts could come up with different postulated rates of improvement. However, we believe that the mechanical extrapolation of recent trends is not an acceptable way of projecting mortality.

Let me discuss now our current assumptions. These are assumptions that, as I said before, the Congress has been using in determining the future of this program. They were used in the deliberations on the 1983 amendments.

The recent trend in decline in mortality is assumed to continue in the near future and then to slowly decelerate until about the year 2007, after which it will be at the rates that we postulated, which are significantly lower than the recent rates of decline.

For the three major causes of death we project that heart diseases will decrease ultimately at a rate of seven-tenths of 1 percent per year; vascular diseases, nine-tenths of 1 percent per year; and cancer, which has been going up recently, will decrease by a quarter of a percent per year.

The effect of mortality assumptions on our cost estimate is something that we consider very carefully. Our mortality projections are not theoretical projections. They are values that are needed and that are essential in the preparation of cost estimates, and we have to come up with values that are reasonable. They are important elements of all of our cost estimates.

In these estimates——

Senator CHAFEE. Let me see if I understand your terms here. On page 14 you are talking about optimistic and pessimistic "optimistic" to me would mean people living longer. I take it that "optimistic" to you is the contrary. You look at it strictly from a cash point of view, don't you? "Optimistic" to you means that they will be dying earlier? I do not mean to be harsh, but is that about the way it is?

Mr. BAYO. That is correct, Mr. Chairman. The labeling is done according to——

Senator CHAFEE. That is a little ghoulish. "Optimistic" means people will die at a very satisfactory rate, is that right?

Mr. BAYO. Yes.

Senator CHAFEE. And pessimism comes over your organization when you find people living longer, is that right?

Mr. BAYO. The set of assumptions that results in the highest cost to the social security program is labeled "pessimistic" and includes the highest rate of increase in mortality, because people living longer and receiving benefits longer will increase the cost of the program.

Senator CHAFEE. Well, in my presentation, I reverse your terms. I think we want to say that it is optimistic when people live longer, but you are looking at it strictly from a cash point of view.

Mr. BAYO. From the point of view of the cost of the program.

Senator CHAFEE. I see. All right.

Mr. BAYO. For example, the cost of the program under the intermediate assumption is now estimated at 12.84 percent of taxable payroll. If we use optimistic assumptions, that is people dying sooner, the costs will decrease by about two-thirds of 1 percent, ac-

tually, 0.66 percent of taxable payroll. If we use pessimistic assumptions, that is, people living longer, then the costs will go up by about 1 percent of payroll, actually 0.97 percent.

What I wanted to emphasize is that the increase or decrease in cost is not as large as we would imagine at first sight, and that there is ample time in which to make those adjustments, because mortality doesn't change that quickly; 2 or 3 percent per year would be a significant change in mortality.

For my final remarks, I would like to say that we have analyzed the recent trends in mortality and incorporated these trends in our cost projections. The Congress used those projections in the 1983 amendments. I see no need to make further changes in the program at this time. There will be ample time to consider new changes if our current projections turn out not to be accurate.

I thank you, Mr. Chairman. Mr. Wilkin and myself are available for questions.

[The prepared statement of Francisco R. Bayo follows:]

DEPARTMENT OF HEALTH & HUMAN SERVICES Social Security Administration
FOR RELEASE ONLY UPON DELIVERY
Refer to: Baltimore MD 21235

STATEMENT

ON TRENDS IN LIFE EXPECTANCY

BY

FRANCISCO R. BAYO

DEPUTY CHIEF ACTUARY

SOCIAL SECURITY ADMINISTRATION

BEFORE THE

SUBCOMMITTEE ON SAVINGS, PENSIONS AND INVESTMENT POLICY

COMMITTEE ON FINANCE

U.S. SENATE

FRIDAY, JULY 15, 1983

Mr. Chairman and members of the Subcommittee, I appreciate this opportunity to appear before you today to discuss the mortality projections that underlie the long-range cost estimates for the Social Security program.

Introduction

As members of this Subcommittee are aware, many people are interested in knowing how changes in mortality affect our nation. Health care planners want to know how changes in mortality will affect longevity so that they can develop and provide services effectively. Industrial and sales planners want to know how changes in mortality will affect the size and the age-sex distribution of the population so that they can make prudent decisions about production and marketing. Actuaries want to stay abreast of changes in mortality to be sure that insurance premiums are properly set and that pension plans are properly funded. At the Social Security Administration we have significant interest in mortality projections because mortality is an important element to

BE TAKEN INTO ACCOUNT IN THE PLANNING OF THE SOCIAL SECURITY PROGRAM AND OF ITS FINANCING.

BEFORE DESCRIBING THE PROJECTIONS THAT WE ARE CURRENTLY USING AND HOW WE DEVELOPED THEM, LET ME MAKE A FEW REMARKS ABOUT ACTUARIAL ASSUMPTIONS IN GENERAL AND MORTALITY PROJECTIONS IN PARTICULAR. NEEDLESS TO SAY, NOBODY KNOWS EXACTLY WHAT WILL HAPPEN IN THE FUTURE, ESPECIALLY A DISTANT FUTURE OF 75 YEARS SUCH AS WE PROJECT FOR SOCIAL SECURITY COST ESTIMATES. THEREFORE, THERE ARE BOUND TO BE MANY DIFFERENT AND SOMETIMES CONFLICTING VIEWS AMONG THE EXPERTS. THESE DIFFERENCES ARE NOT ONLY NORMAL, BUT I WOULD ADD THAT THEY LEAD TO A HEALTHY SITUATION--ONE IN WHICH WE MORE DIRECTLY RECOGNIZE THAT THERE IS SOME UNCERTAINTY ABOUT THE FUTURE. IN FACT, IN ORDER TO MORE PROPERLY CONVEY TO THE CONGRESS THE SENSE OF UNCERTAINTY, WE PRESENT OUR SOCIAL SECURITY COST PROJECTIONS ON THE BASIS OF THREE DIFFERENT SETS OF

25-513 O—83——2

MORTALITY PROJECTIONS: LOW, INTERMEDIATE, AND HIGH MORTALITY IMPROVEMENTS.

THE ASSUMPTIONS NEEDED TO MAKE SOCIAL SECURITY COST ESTIMATES CAN BE GROUPED INTO THREE MAJOR CATEGORIES: ECONOMIC, PROGRAMMATIC, AND DEMOGRAPHIC ASSUMPTIONS. THE FIRST CATEGORY INCLUDES THE MAJOR PARAMETERS THAT ARE USED TO BROADLY DESCRIBE THE OPERATIONS OF THE NATIONAL ECONOMY. AMONG THEM IT WOULD BE WELL TO MENTION THE GROSS NATIONAL PRODUCT, PRODUCTIVITY, PRICE INFLATION, AND UNEMPLOYMENT. THESE VARIABLES ARE SUBJECT TO A RELATIVELY HIGH LEVEL OF VOLATILITY, AND CHANGES IN THEM AFFECT THE LONG-RANGE COST OF THE SOCIAL SECURITY PROGRAM.

THE SECOND CATEGORY OF ASSUMPTIONS COVERS ACTUARIAL PARAMETERS INHERENT TO THE STRUCTURE OF THE PROGRAM'S BENEFITS AND TO THEIR ADMINISTRATION. AMONG THEM WE COULD MENTION THE DISABILITY RATES, THE RETIREMENT RATES, AND THE COVERAGE RATES. AS COMPARED TO THE ECONOMIC ASSUMPTIONS, THE PROGRAMMATIC

ASSUMPTIONS ARE LESS VOLATILE. THEY ARE NOT SUBJECT TO SUCH WIDE SWINGS AND THEY DO NOT CHANGE AS FAST THROUGH TIME.

THE THIRD CATEGORY OF ASSUMPTIONS INCLUDES ELEMENTS RELATED TO THE POPULATION RESIDING IN OUR COUNTRY. AMONG THEM ARE THE FERTILITY RATES, THE MIGRATION RATES, AND THE MORTALITY RATES. THESE RATES ARE RELATIVELY STABLE, WITH NARROWER SWINGS AND SLOWER CHANGES THROUGH TIME THAN THE FIRST TWO CATEGORIES. OF THESE THREE POPULATION-RELATED VARIABLES, THE MORTALITY RATES ARE GENERALLY THE MOST STABLE. THEIR ANNUAL CHANGES ARE RARELY MORE THAN TWO OR THREE PERCENTAGE POINTS. THIS RELATIVE STABILITY AND SLOW MOVEMENT IN THE MORTALITY RATES GENERALLY GIVES PROGRAM PLANNERS CONSIDERABLE TIME IN WHICH TO ANALYZE AND CONFIRM TRENDS BEFORE RECOMMENDING PROGRAM CHANGES.

AT THIS TIME I SEE NO NEED TO BE ALARMED BECAUSE OF THE RECENT FAST IMPROVEMENT IN MORTALITY AT THE OLDER AGES. ANALYSES HAVE BEEN MADE OF THIS FACT AND THE RESULTS OF THESE ANALYSES

INCORPORATED INTO THE COST ESTIMATES THAT THE CONGRESS HAS BEEN USING. IF FUTURE EXPERIENCE SHOULD DEPART GREATLY FROM OUR PROJECTIONS, THIS TOO WILL BE INCORPORATED IN THE REPORTS OF THE BOARD OF TRUSTEES OF THE SOCIAL SECURITY TRUST FUNDS, AND NEW COST ESTIMATES PROVIDED TO THE CONGRESS. BECAUSE OF THE SLOWNESS WITH WHICH CHANGES IN MORTALITY AFFECT SOCIAL SECURITY PROGRAM COSTS, AMPLE TIME WILL BE AVAILABLE IN WHICH TO CONSIDER WHETHER PROGRAM CHANGES SHOULD BE MADE IN RESPONSE TO THE MORTALITY CHANGES.

How Mortality Assumptions are Developed

LET ME USE THIS OPPORTUNITY TO GIVE YOU A BRIEF DESCRIPTION OF THE WORK WE DO IN THE SSA'S OFFICE OF THE ACTUARY REGARDING MORTALITY PROJECTIONS.

A FUNDAMENTAL ELEMENT IN GAUGING THE EFFECTS OF MORTALITY IS THE KNOWLEDGE OF WHAT MORTALITY LEVELS HAVE BEEN, WHAT THEY ARE NOW, AND WHAT THEY MAY BE IN THE FUTURE. IN THE OFFICE OF THE ACTUARY WE HAVE COLLECTED, ANALYZED, AND PROJECTED MORTALITY DATA

FOR CLOSE TO HALF A CENTURY. PROJECTED IMPROVEMENTS IN MORTALITY HAVE BEEN USED FOR COST ESTIMATING PURPOSES SINCE THE PROGRAM STARTED IN 1937. IN THE MID-1970'S WE ACCELERATED OUR SCHEDULE FOR MAKING MORTALITY PROJECTIONS AND CURRENTLY WE REVIEW AND REVISE, IF NECESSARY, THE PROJECTIONS FOR EACH YEAR'S TRUSTEES' REPORT TO THE CONGRESS. IN ADDITION TO INCLUDING THREE ALTERNATIVE SETS OF RATES OF MORTALITY IMPROVEMENT IN THE REPORT, ESTIMATES ARE USUALLY PRESENTED IN REGARD TO THE SENSITIVITY OF THE FINAL COST ESTIMATES TO CHANGES IN MORTALITY ASSUMPTIONS.

THE DATA WE HAVE ACCUMULATED ON MORTALITY EXPERIENCE BACK TO THE YEAR 1900 SHOW THAT THE RATE OF IMPROVEMENT IN MORTALITY--THAT IS, THE RATE OF DECLINE IN THE DEATH RATE--HAS VARIED CONSIDERABLY IN THE PAST AND, HENCE, MAY BE EXPECTED TO VARY IN THE FUTURE. AN EXAMINATION OF DEATH RATES ADJUSTED FOR AGE AND SEX VARIATIONS REVEALS FOUR DISTINCT PERIODS OF DIVERSE MORTALITY RATE IMPROVEMENT. FROM 1900 TO 1936, ANNUAL MORTALITY RATE

IMPROVEMENTS AVERAGED 0.9 PERCENT. FOLLOWING THIS WAS A PERIOD OF RAPID IMPROVEMENTS, 1936-1954, IN WHICH MORTALITY DECREASED AT AN AVERAGE RATE OF 2.3 PERCENT PER YEAR. THE RAPID IMPROVEMENTS IN THESE YEARS RESULTED IN PART FROM THE DEVELOPMENT OF MANY NEW DRUGS USED TO CONTROL INFECTIOUS DISEASES AND TO BETTER PUBLIC HEALTH PRACTICES.

DURING THE PERIOD 1954-1968, THE MORTALITY RATE REMAINED ALMOST FLAT, IMPROVING ONLY 0.1 PERCENT PER YEAR. THE DEATH RATE FOR MALES ACTUALLY INCREASED DURING THIS PERIOD. BECAUSE OF THIS, IN THE EARLY 1970'S MANY EXPERTS BELIEVED THAT FURTHER REDUCTIONS IN MORTALITY WOULD BE DIFFICULT TO ACHIEVE. IT WAS REASONED THAT THE CAUSES OF DEATH THAT COULD BE CONTROLLED (SUCH AS THE INFECTIOUS DISEASES) WERE ALREADY WELL CONTROLLED AND THAT THE CAUSES THAT ACCOUNTED FOR MOST DEATHS (SUCH AS THE DEGENERATIVE DISEASES) WOULD BE DIFFICULT TO CONTROL. HOWEVER, THE DATA SHOW THAT A NEW PERIOD OF RAPID IMPROVEMENT ACTUALLY BEGAN IN 1969.

For the 12-year period ending in 1980 the mortality rate declined at an average of 1.8 percent per year. For the entire period 1900 to 1980 mortality has declined at the average rate of 1.2 percent per year.

For the period 1968-1978, data are available in more detail than for earlier periods, and we have analyzed death rates for 10 major groups of causes of death. The sharpest decline among these death rates was in congenital malformations and diseases of early infancy, averaging over 5 percent per year. For heart disease, vascular disease, digestive disease, and diabetes mellitus, declines in death rates averaged about 2.5 to 4.0 percent per year. Death rates for respiratory disease and accidents, suicide, and homicide averaged about 2 percent reduction per year. Death rates for cirrhosis of the liver and the residual group of Other Causes averaged 0.5 to 1 percent

REDUCTION PER YEAR, WHILE THE DEATH RATE FROM CANCER INCREASED ABOUT 0.5 PERCENT PER YEAR.

WHAT DISTINGUISHES THE RECENT PERIOD OF MORTALITY RATE IMPROVEMENT AS COMPARED TO EARLIER PERIODS IS THE SIGNIFICANT DECLINE IN THE DEATH RATE FOR HEART DISEASES AND VASCULAR DISEASES, WHICH AFFECT MOSTLY OLDER PEOPLE. THESE RECENT TRENDS ARE ESPECIALLY IMPORTANT IN THE PROJECTION OF THE COST OF THE SOCIAL SECURITY PROGRAM. WHEN MORTALITY IMPROVEMENT OCCURS AT THE RETIREMENT AGES, BENEFICIARIES STAY ON THE ROLLS LONGER BUT THERE IS NO OFFSETTING CHANGE IN THE NUMBER OF WORKERS. THIS TYPE OF CHANGE IN MORTALITY ADDS TO THE COST OF THE PROGRAM WITHOUT SIGNIFICANTLY AFFECTING PROGRAM INCOME.

WHEN MORTALITY IMPROVEMENT OCCURS DURING THE WORKING AGES, THE EFFECTS ON THE COST OF THE PROGRAM ARE MIXED. ADDITIONAL NUMBERS OF WORKERS REMAIN ALIVE LONGER TO WORK AND PAY TAXES;

HOWEVER, EVENTUALLY THEY REACH RETIREMENT AGE AND COLLECT BENEFITS.

WHEN MORTALITY IMPROVEMENT OCCURS AT INFANCY OR EARLY CHILDHOOD, THE EFFECT ON SOCIAL SECURITY IS TANTAMOUNT TO A SLIGHT INCREASE IN THE FERTILITY RATE, I.E., THERE IS VERY LITTLE INITIAL EFFECT, LATER THERE IS AN INCREASE IN THE NUMBER OF WORKERS, AND ONLY MUCH LATER IS THERE AN INCREASE IN THE NUMBER OF BENEFICIARIES. THE NET EFFECT IS A DECREASE IN THE PERCENTAGE OF PAYROLL COST OF THE PROGRAM.

AFTER CONSIDERATION OF THE LEVEL AND VARIABILITY OF PAST TRENDS, WE CONSIDER HOW FUTURE MORTALITY WOULD BE AFFECTED BY SUCH FACTORS AS THE DEVELOPMENT AND APPLICATION OF NEW DIAGNOSTIC AND SURGICAL TECHNIQUES, THE ISOLATION AND TREATMENT OF CAUSES OF DISEASE, THE APPEARANCE OF NEW DISEASES (SUCH AS AIDS), THE PRESENCE OF ENVIRONMENTAL POLLUTANTS, IMPROVEMENTS IN EXERCISE AND NUTRITION, THE INCIDENCE OF VIOLENCE, IMPROVEMENTS IN PRENATAL

CARE, THE PREVALENCE OF CIGARETTE SMOKING, THE MISUSE OF DRUGS (INCLUDING ALCOHOL) AND THE EXTENT TO WHICH PEOPLE ASSUME RESPONSIBILITY FOR THEIR OWN HEALTH. ALL OF THESE ARE FACTORED INTO THE PROJECTIONS AS EDUCATED GUESSES OR INFORMED JUDGEMENT BY MEANS OF A CONSENSUS AMONG THE VARIOUS ACTUARIES PARTICIPATING IN THE EFFORT.

IN MAKING A PROJECTION, WE CANNOT JUST ASSUME THAT THE RATES OF IMPROVEMENT THAT HAVE OCCURRED IN THE PAST WILL CONTINUE FOREVER INTO THE FUTURE. FUTURE IMPROVEMENTS WILL BE DIFFERENT FROM PAST IMPROVEMENTS AND WILL COME FROM NEW DEVELOPMENTS. FOR EXAMPLE, THE IMPROVEMENT IN MORTALITY DUE TO THE CONTROL OF INFECTIOUS DISEASES THAT OCCURRED IN THE PAST CANNOT BE USED TO ASSUME SIGNIFICANT IMPROVEMENTS IN MORTALITY FOR THE FUTURE. THE LEADING EDGE OF MEDICAL KNOWLEDGE GIVES US CLUES ON THE VERY NEAR TERM TREND, BUT LONG-RANGE PROJECTIONS MUST ASSUME THAT IMPROVEMENTS WILL OCCUR IN AREAS THAT ARE CURRENTLY UNKNOWN.

IN THE MIDST OF THE LONG-RANGE UNCERTAINTIES ABOUT FUTURE CHANGES, THE BEST THAT WE CAN DO IS TO POSTULATE ULTIMATE ANNUAL RATES OF IMPROVEMENT BY CAUSE OF DEATH AND SEX, KNOWING THAT A DIFFERENT GROUP OF EXPERTS COULD CONCEIVABLY ARRIVE AT A DIFFERENT SET OF POSTULATED RATES. TO INCREASE THE LEVEL OF ACCEPTABILITY OF OUR PROJECTIONS AND TO IMPROVE THE QUALITY OF FUTURE ANALYSES, WE PUBLISH OUR WORK AND SEND COPIES TO KNOWLEDGEABLE GROUPS FOR THEIR COMMENTS. IN ADDITION, WE HAVE HAD THE BENEFIT OF THE OPINIONS OF VARIOUS PANELS OF ACTUARIES AND ECONOMISTS THAT HAVE BEEN APPOINTED BY THE STATUTORY SOCIAL SECURITY ADVISORY COUNCILS TO REVIEW OUR ASSUMPTIONS AND METHODS.

I WOULD LIKE TO POINT OUT THAT BLIND NUMERICAL EXTRAPOLATIONS WITHOUT PROPER ANALYSIS AND WITHOUT THE EXERCISE OF GOOD JUDGEMENT COULD LEAD TO UNACCEPTABLE RESULTS. IF FOR EXAMPLE, THE RECENT RATES OF DECLINE IN MORTALITY FOR THE VARIOUS CAUSES OF DEATH IN WHICH THERE HAVE BEEN IMPROVEMENT WERE ASSUMED TO CONTINUE FOR

MANY DECADES, THE RESULTING RATES WOULD IMPLY LIFE EXPECTANCIES OF OVER 100 YEARS. THIS IS CLOSE TO WHAT SOME EXPERTS BELIEVE IS THE MAXIMUM LIFE SPAN. ON THE OTHER HAND, ASSUMING CONTINUATION OF THE DETERIORATION OF THOSE CAUSES IN WHICH MORTALITY HAS RECENTLY INCREASED WOULD LEAD TO FUTURE LIFE EXPECTANCIES THAT ARE LOWER THAN THOSE WE ARE CURRENTLY EXPERIENCING.

CURRENT ASSUMPTIONS

CURRENTLY THE THREE LEADING CAUSES OF DEATH (DISEASES OF THE HEART, CANCER, AND VASCULAR DISEASES) ACCOUNT FOR OVER TWO-THIRDS OF ALL DEATHS. MORTALITY PROJECTIONS DEPEND HEAVILY ON THE POSTULATED FUTURE COURSE OF THESE CAUSES. AS MAY BE OBSERVED FROM TABLE 1 IN THE ATTACHMENTS TO MY STATEMENT, IN OUR LATEST MORTALITY PROJECTIONS, WHICH SERVED AS THE BASIS FOR THE 1983 TRUSTEES' REPORTS, WE ASSUMED THAT THE RATE OF IMPROVEMENT IN MORTALITY FROM CONTROL OF DISEASES OF THE HEART WOULD ULTIMATELY BE 0.7 PERCENT PER YEAR UNDER ALTERNATIVE II, THE INTERMEDIATE SET

OF ASSUMPTIONS. UNDER ALTERNATIVE I, THE MOST OPTIMISTIC SET OF ASSUMPTIONS IN TERMS OF THEIR EFFECT ON PROJECTED COST, WE ASSUMED AN ULTIMATE AVERAGE ANNUAL RATE OF IMPROVEMENT OF 0.5 PERCENT, WHILE FOR ALTERNATIVE III, THE MOST PESSIMISTIC SET OF ASSUMPTIONS FROM A PROGRAM COST STANDPOINT, WE ASSUMED A 1.0 PERCENT RATE OF IMPROVEMENT, WHICH WOULD REUSLT IN PEOPLE LIVING LONGER AND COLLECTING MORE BENEFITS THAN UNDER ALTERNATIVES I AND II. SOMEWHAT HIGHER RATES OF IMPROVEMENT WERE POSTULATED FOR VASCULAR DISEASES. THE DEATH RATE FROM CANCER HAS ACTUALLY BEEN INCREASING RECENTLY AND ITS FUTURE COURSE SEEMS LESS CERTAIN THAN FOR OTHER CAUSES OF DEATH. BECAUSE OF THIS, A GREATER RANGE OF ULTIMATE RATES OF IMPROVEMENT WERE ASSUMED FOR CANCER. UNDER ALTERNATIVE I, THE DEATH RATE FROM CANCER WAS ASSUMED TO LEVEL OFF ULTIMATELY, WHILE UNDER ALTERNATIVES II AND III ULTIMATE RATES OF IMPROVEMENT OF ABOUT 0.2 AND 0.3 PERCENT PER YEAR AND ABOUT 1.2 TO 1.5 PERCENT PER YEAR, RESPECTIVELY, WERE ASSUMED. ASSUMPTIONS ABOUT THE ULTIMATE AVERAGE ANNUAL RATE OF IMPROVEMENT WERE MADE FOR THE

OTHER GROUPS OF CAUSES OF DEATH IN A SIMILAR MANNER. FOR SOME OF THE CAUSES OF DEATH, THE ULTIMATE RATES OF IMPROVEMENT FOR FEMALES WERE ASSUMED TO BE GREATER THAN FOR MALES. THUS, AS MAY BE NOTED FROM TABLES 2A AND 2C, THE GAP BETWEEN MALE AND FEMALE MORTALITY IS PROJECTED TO CONTINUE TO WIDEN. HOWEVER, THIS IS ASSUMED TO OCCUR AT A DECELERATED RATE FROM THE PAST AS WOMEN BECOME INCREASINGLY SUBJECT TO THE SAME ENVIRONMENTAL PRESSURES AND HAZARDS AS MEN.

THE POSTULATED ULTIMATE RATES OF IMPROVEMENT WERE ASSUMED TO BE APPLIED AFTER THE YEAR 2007, THE 25TH YEAR OF THE PROJECTION PERIOD. WITHIN THE FIRST 25-YEAR PERIOD MORTALITY IMPROVEMENT WAS ASSUMED TO CHANGE GRADUALLY UNDER ALTERNATIVES I, II, AND III FROM 50 PERCENT, 100 PERCENT, AND 150 PERCENT, RESPECTIVELY, OF THE AVERAGE ANNUAL RATES OF IMPROVEMENT OBSERVED DURING 1968-1978 TO THE POSTULATED ULTIMATE RATES.

THE RESULTING AVERAGE ANNUAL RATES OF IMPROVEMENT FOR THE PERIOD 1980 TO 2060 ARE .35 PERCENT, .65 PERCENT, AND 1.17 PERCENT UNDER ALTERNATIVES I, II, AND III, RESPECTIVELY. THIS IS 29 PERCENT, 54 PERCENT, AND 97 PERCENT, RESPECTIVELY, OF THE AVERAGE ANNUAL RATE OF IMPROVEMENT OBSERVED SO FAR IN THIS CENTURY.

IMPROVEMENTS FOR THE YOUNG AGES ARE PROJECTED TO BE RELATIVELY SMALL BECAUSE VERY LITTLE ADDITIONAL IMPROVEMENT IN INFECTIOUS DISEASES IS POSSIBLE AND LITTLE IMPROVEMENT IN MORTALITY FROM VIOLENT CAUSES IS EXPECTED. HOWEVER, IMPROVEMENTS FOR THE AGED ARE EXPECTED TO CONTINUE AT A RELATIVELY RAPID PACE AS FURTHER STRIDES ARE MADE AGAINST DEGENERATIVE DISEASES. FOR PERSONS AGE 65 OR OVER, WE ARE PROJECTING THAT THE AVERAGE ANNUAL RATE OF IMPROVEMENT IN MORTALITY FOR THE NEXT 80 YEARS, UNDER INTERMEDIATE ASSUMPTIONS, WILL BE ABOUT THE SAME AS THAT OBSERVED IN THE LAST 80 YEARS.

From Table 3a it can be noted that, as a result of our assumptions, life expectancy at birth for males, which increased from 46.6 years in 1900 to 69.8 years in 1980 is projected to be 73.4 years, 76.3 years, and 81.3 years under alternatives I, II, and III, respectively, by the year 2060. For females, the corresponding figures are 49.1 years in 1900, 77.5 years in 1980 and a projected 81.2 years, 84.4 years, and 89.7 years under alternatives I, II, and III, respectively, in 2060.

For males, life expectancy at age 65, which as can be seen from Table 3b increased by 2.7 years in the last 80 years (from 11.3 in 1900 to 14.0 years in 1980) is projected to increase in the next 80 years by 2.0 years, 2.9 years, and 7.7 years (to 16.0 years, 17.9 years, and 21.7 years in 2060) under alternatives I, II, and III, respectively. For females, the corresponding figures are 12.0 years in 1900, 18.3 years in 1980, for an increase of 6.3 years in the last 80 years, and 21.2 years,

23.6 YEARS, AND 27.7 YEARS IN 2060 UNDER ALTERNATIVES I, II, AND III, RESPECTIVELY, FOR ASSUMED INCREASES OF 2.9 YEARS, 5.3 YEARS, AND 9.4 YEARS.

EFFECT OF CHANGES IN ASSUMPTIONS IN THE LONG-RANGE COST ESTIMATES

THE THEORETICAL PROJECTION OF MORTALITY RATES IS NOT IN ITSELF OUR MAJOR GOAL. THE IMPORTANCE OF THE MORTALITY RATE PROJECTION STEMS FROM ITS USE IN THE POPULATION PROJECTIONS THAT FORM THE BASIS OF LONG-RANGE SOCIAL SECURITY COST ESTIMATES. AS SUCH IT IS JUST ONE OF THE MANY ASSUMPTIONS USED TO PRODUCE COST ESTIMATES. BECAUSE THE GROWTH IN THE NUMBER OF SOCIAL SECURITY BENEFICIARIES FOLLOWS CLOSELY THE GROWTH IN THE GENERAL POPULATION ABOVE NORMAL RETIREMENT AGE, AND THE GROWTH IN THE NUMBER OF WORKERS PAYING SOCIAL SECURITY TAXES FOLLOWS CLOSELY THE GROWTH IN THE POPULATION IN THE WORKING AGES (AGE 20 THROUGH THE NORMAL RETIREMENT AGE), THE RATIO OF THESE TWO POPULATIONS AND ITS CHANGES THROUGH TIME GIVE A GOOD INDICATION OF THE FUTURE COST OF

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THE SOCIAL SECURITY PROGRAM. THIS RATIO IS REFERRED TO AS THE "AGED DEPENDENCY RATIO" AND CAN BE USED TO OBTAIN AN IDEA OF THE EFFECT ON THE PROJECTED SOCIAL SECURITY COST OF VARIATIONS IN THE MORTALITY ASSUMPTIONS, OR ANY OTHER DEMOGRAPHIC ASSUMPTION.

TABLE 4 SHOWS THE CHANGES IN THE AGED DEPENDENCY RATIO (FROM A VALUE OF 20 PERCENT IN 1983) AND IN THE LONG-RANGE COST OF THE OASDI SYSTEM THAT ARE PROJECTED UNDER THE ALTERNATIVE SETS OF ASSUMPTIONS I, II-B AND III OF THE 1983 TRUSTEES' REPORT. THE COST ESTIMATES SHOWN IN THE UPPER PORTION OF THE TABLE REFER TO THE COMBINED EFFECT OF ALL THE ECONOMIC, PROGRAMMATIC, AND DEMOGRAPHIC ASSUMPTIONS INVOLVED IN EVERY ALTERNATIVE SET. THE OPTIMISTIC SET OF ASSUMPTIONS IN ALTERNATIVE I YIELDS A LONG-RANGE 75-YEAR AVERAGE COST OF 9.81 PERCENT OF TAXABLE PAYROLL. THE INTERMEDIATE SET IN ALTERNATIVE II-B YIELDS A COST OF 12.84; WHILE THE PESSIMISTIC SET IN ALTERNATIVE III YIELDS A COST OF 16.56. THIS WIDE RANGE IN PROJECTED COST IS DUE IN PART TO ASSUMED

VARIATIONS IN FUTURE MORTALITY, BUT MOST OF IT IS DUE TO ASSUMED VARIATIONS IN THE OTHER ASSUMPTIONS USED TO PREPARE THE ESTIMATES.

IT CAN BE SEEN FROM THE BOTTOM PORTION OF TABLE 4 THAT IF IN THE SET OF INTERMEDIATE II-B ASSUMPTIONS THE MORTALITY PROJECTION WERE MODIFIED TO MAKE IT AS OPTIMISTIC AS IN ALTERNATIVE I (ASSUMING ALL OTHER ASSUMPTIONS IN II-B WERE RETAINED) THE PROJECTED LONG-RANGE OASDI COST WOULD DECREASE BY 0.66 PERCENT OF PAYROLL (FROM 12.84 TO 12.18). THIS MEANS THAT OF THE DIFFERENCE OF 3.03 PERCENT OF TAXABLE PAYROLL IN PROJECTED COST BETWEEN ALTERNATIVES I AND II-B (12.84 MINUS 9.81) ABOUT 0.66 PERCENT OF TAXABLE PAYROLL IS DUE TO THE MORE OPTIMISTIC MORTALITY ASSUMPTIONS.

SIMILARLY, IF IN ALTERNATIVE II-B THE MORTALITY PROJECTION WERE MODIFIED TO MAKE IT AS PESSIMISTIC AS IN ALTERNATIVE III (ASSUMING ALL OTHER ASSUMPTIONS IN II-B WERE RETAINED) THE PROJECTED LONG-RANGE OASDI COST WOULD INCREASE BY 0.97 PERCENT OF

TAXABLE PAYROLL (FROM 12.84 TO 13.81). OF THE 3.72 PERCENT OF TAXABLE PAYROLL DIFFERENCE BETWEEN ALTERNATIVE II-B AND III (FROM 12.84 TO 16.56) ABOUT 0.97 PERCENT OF TAXABLE PAYROLL IS DUE TO THE MORE PESSIMISTIC MORTALITY ASSUMPTIONS.

FINAL REMARKS

THE RECENT TRENDS IN LIFE EXPECTANCY HAVE BEEN ANALYZED BY THE OFFICE OF THE ACTUARY AND THE RESULTS INCORPORATED IN THE ASSUMPTIONS FOR THE OASDI COST PROJECTIONS THAT ARE BEING USED BY THE CONGRESS.

THE INTERMEDIATE COST PROJECTIONS ASSUME THAT THE RECENT TRENDS IN MORTALITY WILL CONTINUE FOR A FEW MORE YEARS AND THEN DECELERATE GRADUALLY TO SLOWER RATES OF IMPROVEMENT BY THE YEAR 2007.

THERE IS NO NEED TO MAKE SIGNIFICANT PROGRAM CHANGES NOW TO RECOGNIZE MORTALITY IMPROVEMENTS. ANY DEVIATION IN FUTURE MORTALITY EXPERIENCE FROM OUR CURRENT PROJECTIONS WILL BE ANALYZED AND INCORPORATED INTO REPORTS TO CONGRESS WITH AMPLE TIME TO DETERMINE WHETHER CHANGES MAY BE NEEDED IN THE SOCIAL SECURITY PROGRAM.

ATTACHMENT

Table 1. Postulated Ultimate Annual Percentage Improvements In Central Death Rates For The 1983 OASDI Trustees Report, by Alternative 1/, Sex, and Cause

Group of Causes of Diseases	Code Numbers 2/	Annual Percentage Improvement					
		Alternative I		Alternative II		Alternative III	
		Male	Female	Male	Female	Male	Female
I. Diseases of the Heart	390-398, 402, 404, 410-429	0.5	0.5	0.7	0.7	1.0	1.0
II. Malignant Neoplasms	140-209	0.0	0.0	0.2	0.3	1.2	1.5
III. Vascular Diseases	400-401, 403, 430-458, 582-584	0.7	0.7	0.9	0.9	1.2	1.5
IV. Accidents, Suicide, and Homicide	E800-E989	0.0	0.0	0.0	0.0	0.0	0.0
V. Diseases of the Respiratory System	460-519	0.0	0.0	0.1	0.2	0.3	0.5
VI. Congenital Malformations and Diseases of Early Infancy	740-778	0.7	0.7	1.0	1.0	1.5	1.5
VII. Diseases of the Digestive System	520-570, 572-577	0.4	0.4	0.7	0.7	1.0	1.0
VIII. Diabetes Mellitus	250	0.2	0.2	0.4	0.5	0.8	1.0
IX. Cirrhosis of the Liver	571	0.0	0.0	0.2	0.2	0.5	0.5
X. All Other Causes		0.1	0.1	0.3	0.3	0.5	0.5

1/ Cost estimates in the 1983 OASDI Trustees Report were presented on the basis of four alternative sets assumptions; namely alternatives I, II-A, II-B, and III. Alternatives II-A and II-B, although differing in their economic and programmatic assumptions, share the same demographic assumptions. In terms of the effect on the projected cost of the OASDI program, alternative I is the most optimistic set of assumptions and alternative III is the most pessimistic.

2/ The code numbers refer to the Eighth Revision of the International List of Diseases and Causes of Death.

Table 2a. Alternative I Central Death Rates, by Age, Sex, and Calendar Year (per hundred thousand)

Sex	Age	Calendar Year										
		1981	1990	2000	2010	2020	2030	2040	2050	2060	2070	2080
Male	0	1316.9	1272.4	1261.7	1217.1	1174.0	1133.4	1095.1	1059.0	1024.9	992.7	962.4
	1-4	69.0	62.9	59.0	58.0	57.2	56.5	55.8	55.1	54.5	53.9	53.3
	5-9	31.8	27.7	25.3	25.0	24.8	24.6	24.5	24.3	24.2	24.1	23.9
	10-14	37.1	33.9	31.7	31.4	31.2	31.0	30.8	30.7	30.5	30.4	30.2
	15-19	130.5	123.6	118.7	118.0	117.7	117.4	117.2	116.9	116.7	116.4	116.2
	20-24	181.4	171.2	163.7	162.8	162.4	162.0	161.6	161.3	161.0	160.6	160.3
	25-29	195.7	188.2	182.9	181.7	181.0	180.4	179.8	179.2	178.6	178.0	177.5
	30-34	192.6	176.1	165.1	163.4	162.3	161.3	160.4	159.5	158.6	157.8	157.0
	35-39	241.3	216.5	200.3	197.3	195.1	193.0	191.1	189.2	187.4	185.7	184.1
	40-44	362.9	323.9	297.8	291.5	286.7	282.1	277.7	273.6	269.6	265.9	262.3
	45-49	570.8	519.8	485.5	474.7	465.6	456.9	448.6	440.7	433.2	426.1	419.3
	50-54	929.8	862.2	816.8	798.5	782.3	766.9	752.2	738.3	725.0	712.4	700.5
	55-59	1426.4	1287.1	1192.4	1161.0	1134.9	1110.0	1086.5	1064.0	1042.8	1022.5	1003.3
	60-64	2159.0	2016.7	1917.2	1870.5	1828.4	1788.4	1750.5	1714.4	1680.2	1647.7	1616.8
	65-69	3430.9	3289.8	3179.3	3101.8	3030.3	2962.5	2898.2	2837.2	2779.3	2724.3	2672.1
	70-74	5006.4	4834.0	4688.7	4568.9	4458.4	4353.7	4254.4	4160.3	4071.0	3986.3	3905.9
	75-79	7283.3	7044.1	6838.7	6654.5	6481.1	6316.9	6161.3	6013.8	5874.1	5741.6	5616.0
	80-84	10654.7	10348.7	10081.7	9798.9	9531.9	9279.0	9039.5	8812.5	8597.5	8393.8	8200.7
	85-89	16242.3	15697.9	15204.3	14732.4	14292.1	13875.2	13480.6	13106.9	12753.1	12417.9	12100.4
	90-94	23347.4	22244.3	21242.1	20485.8	19799.6	19150.2	18535.4	17953.4	17402.4	16880.5	16386.3
Female	0	1089.8	1022.4	1001.0	963.0	926.9	892.9	860.9	830.7	802.3	775.5	750.3
	1-4	54.0	48.2	44.8	43.9	43.2	42.6	42.0	41.4	40.8	40.3	39.8
	5-9	25.2	21.8	19.8	19.6	19.4	19.2	19.0	18.9	18.7	18.6	18.4
	10-14	33.3	21.3	20.0	19.8	19.6	19.4	19.2	19.1	18.9	18.8	18.6
	15-19	47.0	44.9	43.8	43.6	43.4	43.2	43.0	42.9	42.7	42.6	42.4
	20-24	56.6	54.8	54.3	54.1	53.8	53.6	53.4	53.1	52.9	52.7	52.5
	25-29	69.1	63.0	59.4	58.8	58.4	58.1	57.7	57.4	57.1	56.8	56.5
	30-34	81.2	70.3	64.2	63.4	62.9	62.4	61.9	61.5	61.0	60.6	60.3
	35-39	117.7	99.5	89.3	87.8	86.8	85.9	85.0	84.1	83.3	82.6	81.8
	40-44	202.4	178.6	163.6	160.8	158.8	156.9	155.1	153.4	151.7	150.2	148.7
	45-49	316.2	285.0	264.3	259.5	256.0	252.7	249.5	246.5	243.6	240.9	238.4
	50-54	488.2	449.8	423.2	415.4	409.3	403.4	397.9	392.7	387.7	383.0	378.5
	55-59	749.0	697.5	664.1	652.6	642.2	632.4	623.1	614.2	605.8	597.9	590.3
	60-64	1132.7	1105.7	1088.9	1069.8	1051.3	1033.7	1017.1	1001.3	986.2	972.0	958.5
	65-69	1726.8	1680.0	1649.7	1615.9	1583.0	1551.9	1522.3	1494.3	1467.7	1442.5	1418.5
	70-74	2616.7	2434.6	2316.2	2255.2	2198.4	2144.7	2093.7	2045.4	1999.6	1956.2	1915.0
	75-79	4108.8	3725.9	3457.9	3342.5	3240.0	3142.9	3050.9	2963.8	2881.3	2803.1	2729.0
	80-84	6757.0	6118.2	5661.6	5451.8	5264.6	5087.6	4919.9	4761.3	4611.1	4468.9	4334.2
	85-89	11261.9	10258.9	9496.2	9113.6	8773.2	8450.9	8146.0	7857.4	7584.3	7325.8	7081.0
	90-94	18148.6	16919.2	15878.0	15213.1	14613.5	14046.3	13509.7	13001.9	12521.3	12066.4	11635.8

Note: The central death rate is the ratio of the number of deaths during the year to persons at the tabulated age to the midyear population at that age.

Table 2b. Alternative II Central Death Rates, By Age, Sex, and Calendar Year (per hundred thousand)

Sex	Age	Calendar Year 1981	1990	2000	2010	2020	2030	2040	2050	2060	2070	2080
Male	0	1316.9	1054.6	990.0	936.1	885.2	838.0	794.2	753.5	715.6	680.3	647.5
	1-4	69.0	57.2	51.3	49.8	48.7	47.7	46.7	45.8	44.9	44.1	43.4
	5-9	31.8	24.2	20.8	20.4	20.1	19.9	19.8	19.4	19.2	19.0	18.8
	10-14	37.1	31.0	27.7	27.3	26.9	26.6	26.4	26.1	25.9	25.6	25.4
	15-19	130.8	117.4	109.8	108.6	108.1	107.7	107.2	106.8	106.4	106.1	105.7
	20-24	181.4	161.8	150.0	148.7	148.1	147.6	146.9	146.2	145.8	145.3	144.8
	25-29	195.7	180.8	171.9	170.2	168.9	167.8	166.7	165.6	164.6	163.6	162.7
	30-34	192.6	181.6	145.0	142.6	141.0	139.4	137.9	136.5	135.1	133.9	132.6
	35-39	241.3	198.0	171.6	167.4	164.3	161.3	158.5	155.9	153.4	151.0	148.7
	40-44	362.9	290.0	252.0	243.6	236.7	230.3	224.2	218.5	213.0	207.9	203.0
	45-49	570.8	473.4	422.1	407.6	394.0	381.0	368.8	357.3	346.4	336.0	326.2
	50-54	929.8	788.8	715.1	687.7	662.9	639.6	617.4	596.5	576.7	557.9	540.1
	55-59	1426.4	1167.4	1034.8	993.0	953.9	917.9	883.9	851.6	821.4	792.7	765.4
	60-64	2159.0	1852.6	1686.4	1617.4	1554.4	1495.0	1438.9	1385.9	1335.7	1288.2	1243.4
	65-69	3430.9	3052.4	2827.0	2710.2	2602.8	2501.9	2405.9	2315.7	2230.4	2149.8	2073.5
	70-74	5006.4	4486.8	4170.0	3993.2	3831.1	3678.3	2834.2	2398.4	3270.3	3149.3	3034.9
	75-79	7283.3	6570.4	6130.8	5865.7	5618.8	5386.8	5168.5	4963.0	4769.5	4587.2	4415.2
	80-84	10654.7	9568.9	8930.0	8534.6	8166.6	7821.0	7496.3	7191.2	6904.1	6633.9	6379.5
	85-89	16243.3	14528.3	13467.1	12829.1	12241.2	11690.4	11174.1	10689.9	10235.5	9808.8	9408.0
	90-94	23347.4	20707.4	18936.2	17953.6	17084.1	16232.5	15454.9	14727.2	14046.1	13408.1	12810.3
Female	0	1069.8	856.6	791.7	745.9	703.2	663.7	627.3	593.3	561.9	533.8	506.7
	1-4	54.0	42.7	37.8	36.4	35.4	34.5	33.7	32.9	32.2	31.5	30.9
	5-9	25.3	19.0	16.2	15.8	15.4	15.2	14.9	14.6	14.4	14.1	13.9
	10-14	23.3	19.6	17.7	17.3	17.0	16.7	16.4	16.2	15.9	15.7	15.5
	15-19	47.0	42.9	41.3	40.9	40.6	40.3	40.1	39.8	39.5	39.3	39.1
	20-24	56.6	51.7	50.4	50.0	49.5	49.1	48.8	48.4	48.1	47.7	47.4
	25-29	69.1	58.0	52.8	51.9	51.2	50.5	49.8	49.3	48.7	48.1	47.6
	30-34	81.3	61.4	53.1	51.7	50.7	49.8	48.9	48.0	47.2	46.4	45.6
	35-39	117.7	84.4	70.8	68.2	66.0	64.7	63.0	61.5	60.0	58.6	57.2
	40-44	203.4	158.1	136.1	131.1	127.0	123.1	119.5	115.9	112.6	109.4	106.4
	45-49	316.2	257.9	228.8	217.8	210.1	203.0	196.2	189.7	183.5	177.6	172.0
	50-54	488.2	416.4	377.2	362.5	349.1	336.4	324.3	312.7	301.7	291.3	281.3
	55-59	749.0	647.6	595.2	571.9	550.1	529.4	509.7	490.9	473.1	456.1	439.9
	60-64	1132.7	1028.1	973.8	935.1	897.8	862.5	828.9	797.0	766.7	737.8	710.4
	65-69	1726.6	1550.6	1461.3	1399.7	1340.6	1284.7	1231.7	1181.5	1134.0	1088.8	1046.0
	70-74	2618.7	2221.2	2025.6	1931.1	1842.8	1759.5	1681.0	1606.9	1536.9	1470.7	1408.2
	75-79	4108.8	3374.0	2988.5	2831.3	2688.9	2555.2	2429.7	2311.7	2200.8	2096.5	1998.3
	80-84	6757.0	5495.0	4817.6	4545.3	4300.9	4072.2	3858.0	3657.4	3469.3	3293.0	3127.6
	85-89	11281.9	9257.9	8104.0	7619.7	7188.1	6784.9	6408.3	6056.2	5727.0	5419.1	5130.9
	90-94	18148.6	15530.2	13825.0	12973.2	12212.1	11502.4	10840.1	10222.0	9644.8	9108.7	8603.0

Note: The central death rate is the ratio of the number of deaths during the year to persons at the tabulated age to the midyear population at that age.

Table 2c. Alternative III Central Death Rates, by Age, Sex, and Calendar Year (per hundred thousand)

Sex	Age	Calendar Year										
		1981	1990	2000	2010	2020	2030	2040	2050	2060	2070	2080
Male	0	1316.9	881.7	788.0	726.2	669.7	618.9	573.0	531.5	494.0	459.9	428.9
	1-4	69.0	52.3	44.9	43.0	41.5	40.2	38.9	37.8	36.9	36.0	35.2
	5-9	31.8	21.3	17.3	16.7	16.2	15.8	15.5	15.2	14.9	14.6	14.4
	10-14	37.1	28.4	24.3	23.6	23.1	22.6	22.2	21.8	21.4	21.1	20.8
	15-19	130.5	111.7	101.7	100.4	99.6	98.9	98.3	97.7	97.1	96.7	96.2
	20-24	181.4	153.2	138.2	136.4	135.4	134.4	133.6	132.8	132.0	131.4	130.8
	25-29	195.7	174.1	162.4	159.6	157.5	155.6	153.9	152.3	150.8	149.5	148.2
	30-34	192.6	148.6	128.1	124.5	121.8	119.4	117.1	115.1	113.3	111.5	110.0
	35-39	241.3	176.2	147.7	141.5	136.5	132.0	128.0	124.2	120.8	117.8	115.0
	40-44	362.9	260.2	213.6	200.1	188.9	178.8	169.6	161.4	153.9	147.1	140.9
	45-49	570.8	432.9	368.3	338.7	312.8	289.9	268.5	249.6	233.5	217.2	203.3
	50-54	929.8	724.0	621.8	566.8	518.1	474.4	435.1	399.8	368.1	339.5	313.8
	55-59	1426.4	1063.7	896.3	812.8	738.9	672.6	613.1	559.6	511.6	468.4	429.6
	60-64	2159.0	1706.9	1470.5	1332.3	1209.5	1099.4	1000.5	911.6	831.8	760.0	695.4
	65-69	3430.9	2836.9	2483.5	2252.4	2046.7	1862.0	1695.9	1546.6	1412.3	1291.3	1182.4
	70-74	5006.4	4171.2	3664.4	3328.3	3025.6	2755.4	2512.3	2293.6	2098.7	1919.4	1759.5
	75-79	7283.3	6140.1	5448.8	4966.9	4533.7	4143.8	3792.0	3475.0	3189.0	2930.7	2697.4
	80-84	10654.7	8863.9	7851.3	7171.2	6559.7	6008.2	5510.4	5060.8	4654.8	4287.1	3954.5
	85-89	16242.3	13468.7	11861.0	10836.2	9918.9	9090.8	8342.7	7666.4	7054.8	6500.8	5999.1
	90-94	23347.4	19310.7	16836.1	15368.6	14065.6	12888.4	11824.3	10861.9	9990.9	9202.2	8487.4
Female	0	1069.8	722.7	633.7	580.6	532.8	490.1	451.7	417.3	386.2	358.2	332.8
	1-4	54.0	38.0	31.9	30.3	29.1	28.0	27.0	26.1	25.3	24.6	24.0
	5-9	25.2	16.5	13.2	12.7	12.2	11.8	11.4	11.1	10.8	10.6	10.3
	10-14	23.3	18.1	15.8	15.2	14.7	14.2	13.9	13.5	13.2	13.0	12.7
	15-19	47.0	41.2	39.3	38.7	38.2	37.8	37.4	37.0	36.7	36.4	36.2
	20-24	56.6	48.2	47.1	46.5	45.8	45.2	44.7	44.2	43.8	43.5	43.1
	25-29	69.1	53.8	47.4	45.7	44.5	43.3	42.3	41.4	40.6	39.9	39.3
	30-34	81.2	54.0	44.0	41.5	39.6	37.8	36.3	35.0	33.8	32.8	31.9
	35-39	117.7	71.8	55.3	51.1	47.7	44.6	42.0	39.7	37.6	35.8	34.2
	40-44	202.4	140.3	111.7	101.4	92.8	85.3	78.7	73.0	67.9	63.4	59.5
	45-49	316.2	234.1	193.2	173.1	155.8	140.7	127.5	115.9	105.8	96.9	89.1
	50-54	488.2	388.9	331.6	294.7	262.4	234.3	209.8	188.3	169.5	153.1	138.6
	55-59	749.0	604.0	523.9	464.9	413.3	368.2	328.8	294.2	264.1	237.6	214.3
	60-64	1132.7	958.6	852.7	759.2	676.6	604.2	540.6	484.8	435.7	392.5	354.4
	65-69	1726.6	1435.4	1271.3	1134.7	1013.7	907.4	813.9	731.4	658.7	594.5	537.7
	70-74	2616.7	2038.1	1758.1	1569.2	1405.1	1260.4	1132.7	1019.9	920.0	831.6	753.2
	75-79	4106.8	3069.4	2571.7	2300.7	2064.0	1854.8	1669.5	1505.2	1359.5	1230.0	1114.8
	80-84	6757.0	4950.7	4081.9	3652.2	3279.1	2948.5	2655.3	2394.9	2163.5	1957.4	1773.8
	85-89	11261.9	8372.2	6889.5	6175.6	5557.6	5008.3	4519.5	4084.1	3695.8	3349.2	3039.4
	90-94	18148.6	14274.5	11987.1	10772.5	9719.0	8779.3	7940.4	7190.7	6520.0	5919.4	5381.0

Note: The central death rate is the ratio of the number of deaths during the year to persons at the tabulated age to the midyear population at that age.

Table 3a. Life Expectancy at Birth, by Sex, Calendar Year, and Alternative (in years)

Calendar Year	Sex		Calendar Year	Sex		Calendar Year	Sex and Alternative					
							I		II		III	
	Male	Female		Male	Female		Male	Female	Male	Female	Male	Female
1900	46.6	49.1	1940	60.9	65.3	1980	69.8	77.5	69.8	77.5	69.8	77.5
1901	48.0	51.0	1941	61.4	66.1	1981	70.3	77.8	70.3	77.8	70.3	77.8
1902	49.1	52.2	1942	62.1	66.9	1982	70.4	77.9	70.6	78.1	70.7	78.2
1903	49.3	52.2	1943	62.0	66.9	1983	70.5	78.0	70.8	78.3	71.1	78.6
1904	48.2	51.2	1944	62.4	67.5	1984	70.6	78.1	71.1	78.5	71.5	79.0
1905	48.9	52.0	1945	62.5	68.2	1985	70.7	78.2	71.3	78.8	71.8	79.3
1906	48.4	52.1	1946	63.4	68.6	1986	70.8	78.3	71.5	79.0	72.2	79.7
1907	48.4	52.3	1947	64.4	69.5	1987	70.9	78.4	71.7	79.2	72.5	80.0
1908	50.3	53.7	1948	64.6	69.9	1988	71.0	78.5	71.9	79.4	72.8	80.3
1909	51.2	54.5	1949	65.0	70.4	1989	71.1	78.6	72.1	79.7	73.1	80.6
1910	50.2	53.7	1950	65.3	70.9	1990	71.1	78.7	72.3	79.8	73.4	80.9
1911	51.9	55.1	1951	65.4	71.1	1991	71.2	78.8	72.5	80.0	73.6	81.2
1912	52.4	55.9	1952	65.5	71.4	1992	71.3	78.9	72.6	80.2	73.9	81.5
1913	51.8	55.5	1953	65.7	71.8	1993	71.4	78.9	72.8	80.4	74.1	81.7
1914	53.0	56.4	1954	66.5	72.6	1994	71.4	79.0	72.9	80.5	74.3	81.9
1915	53.6	56.9	1955	66.6	72.7	1995	71.5	79.1	73.0	80.6	74.5	82.1
1916	52.5	56.1	1956	66.6	72.8	1996	71.5	79.2	73.1	80.7	74.6	82.2
1917	52.3	56.0	1957	66.3	72.6	1997	71.6	79.2	73.2	80.8	74.8	82.4
1918	45.4	49.1	1958	66.5	72.9	1998	71.6	79.3	73.3	80.9	74.9	82.5
1919	54.3	56.5	1959	66.7	73.2	1999	71.7	79.3	73.4	81.0	75.0	82.7
1920	54.6	56.3	1960	66.6	73.2	2000	71.7	79.3	73.4	81.0	75.1	82.8
1921	57.3	59.3	1961	67.0	73.6	2005	71.9	79.5	73.7	81.3	75.7	83.4
1922	57.1	59.4	1962	66.8	73.5	2010	72.0	79.7	73.9	81.6	76.2	84.0
1923	56.4	58.8	1963	66.6	73.4	2015	72.2	79.8	74.2	81.9	76.7	84.6
1924	57.2	60.0	1964	66.8	73.7	2020	72.3	80.0	74.4	82.2	77.3	85.2
1925	57.3	60.0	1965	66.8	73.8	2025	72.5	80.1	74.7	82.5	77.8	85.8
1926	56.6	59.4	1966	66.7	73.9	2030	72.6	80.3	74.9	82.7	78.3	86.4
1927	58.0	60.9	1967	66.9	74.3	2035	72.8	80.4	75.1	83.0	78.8	86.9
1928	56.8	59.9	1968	66.6	74.2	2040	72.9	80.6	75.4	83.3	79.3	87.5
1929	57.1	60.3	1969	66.8	74.5	2045	73.0	80.7	75.6	83.6	79.8	88.1
1930	58.0	61.4	1970	67.1	74.8	2050	73.2	80.9	75.8	83.8	80.3	88.6
1931	58.6	62.1	1971	67.4	75.1	2055	73.3	81.0	76.1	84.1	80.8	89.2
1932	59.5	62.6	1972	67.4	75.2	2060	73.4	81.2	76.3	84.4	81.3	89.7
1933	59.6	63.1	1973	67.6	75.5	2065	73.6	81.3	76.5	84.7	81.8	90.3
1934	58.9	62.7	1974	68.2	76.0	2070	73.7	81.5	76.8	84.9	82.3	90.8
1935	59.5	63.4	1975	68.8	76.6	2075	73.8	81.6	77.0	85.2	82.8	91.4
1936	58.8	62.9	1976	69.1	76.8	2080	73.9	81.8	77.2	85.5	83.3	91.9
1937	59.4	63.6	1977	69.4	77.2							
1938	60.9	64.8	1978	69.6	77.3							
1939	61.5	65.4	1979	69.9	77.8							

Note: The life expectancy is the average number of years of life remaining to a person if he were to experience the age-specific mortality rates for the tabulated year throughout the remainder of his life.

Table 3b. Life Expectancy at Age 65, by Sex, Calendar Year, and Alternative (in years)

Calendar Year	Sex	
	Male	Female
1900	11.3	12.0
1901	11.3	12.0
1902	11.7	12.6
1903	11.4	12.2
1904	11.1	11.9
1905	11.4	12.0
1906	11.4	12.2
1907	11.0	11.8
1908	11.6	12.3
1909	11.6	12.4
1910	11.4	12.1
1911	11.5	12.2
1912	11.5	12.3
1913	11.6	12.4
1914	11.6	12.4
1915	11.4	12.2
1916	11.3	12.0
1917	11.2	12.1
1918	11.6	12.5
1919	12.3	12.8
1920	11.8	12.3
1921	12.2	12.8
1922	11.8	12.4
1923	11.5	12.2
1924	11.8	12.6
1925	11.6	12.5
1926	11.4	12.2
1927	11.7	12.7
1928	11.3	12.3
1929	11.4	12.4
1930	11.8	12.9
1931	12.0	13.1
1932	11.9	13.0
1933	12.0	13.2
1934	11.9	13.1
1935	11.9	13.2
1936	11.6	12.8
1937	11.8	13.1
1938	12.1	13.5
1939	12.0	13.4

Calendar Year	Sex	
	Male	Female
1940	11.9	13.4
1941	12.2	13.8
1942	12.4	14.1
1943	12.1	13.7
1944	12.5	14.1
1945	12.6	14.4
1946	12.9	14.6
1947	12.6	14.5
1948	12.7	14.7
1949	12.8	14.9
1950	12.8	15.1
1951	12.8	15.2
1952	13.0	15.3
1953	12.9	15.3
1954	13.2	15.7
1955	13.1	15.6
1956	13.0	15.7
1957	12.9	15.6
1958	12.9	15.7
1959	13.1	15.9
1960	12.9	15.9
1961	13.1	16.1
1962	12.9	16.0
1963	12.7	16.0
1964	13.0	16.3
1965	12.9	16.3
1966	12.9	16.3
1967	13.0	16.6
1968	12.8	16.6
1969	13.0	16.9
1970	13.1	17.1
1971	13.1	17.1
1972	13.1	17.2
1973	13.2	17.4
1974	13.5	17.7
1975	13.7	18.0
1976	13.7	18.1
1977	13.9	18.3
1978	13.9	18.3
1979	14.2	18.6

Calendar Year	Sex and Alternative					
	I		II		III	
	Male	Female	Male	Female	Male	Female
1980	14.0	18.3	14.0	18.3	14.0	18.3
1981	14.2	18.5	14.2	18.5	14.2	18.5
1982	14.3	18.6	14.3	18.7	14.4	18.8
1983	14.3	18.7	14.4	18.9	14.6	19.0
1984	14.3	18.8	14.5	19.0	14.8	19.3
1985	14.4	18.8	14.6	19.2	14.9	19.5
1986	14.4	18.9	14.7	19.3	15.1	19.8
1987	14.4	19.0	14.8	19.5	15.2	20.0
1988	14.5	19.0	14.9	19.6	15.4	20.2
1989	14.5	19.1	15.0	19.8	15.6	20.4
1990	14.5	19.2	15.1	19.9	15.7	20.7
1991	14.5	19.2	15.2	20.0	15.8	20.9
1992	14.6	19.3	15.3	20.2	16.0	21.0
1993	14.6	19.3	15.3	20.3	16.1	21.2
1994	14.6	19.4	15.4	20.4	16.2	21.4
1995	14.6	19.4	15.5	20.5	16.3	21.5
1996	14.7	19.5	15.5	20.6	16.4	21.6
1997	14.7	19.5	15.6	20.6	16.5	21.8
1998	14.7	19.6	15.6	20.7	16.6	21.9
1999	14.7	19.6	15.7	20.8	16.7	22.0
2000	14.8	19.6	15.7	20.8	16.8	22.1
2005	14.9	19.8	15.9	21.0	17.2	22.5
2010	15.0	19.9	16.1	21.3	17.6	23.0
2015	15.1	20.0	16.3	21.5	18.0	23.5
2020	15.2	20.2	16.4	21.7	18.4	24.0
2025	15.3	20.3	16.6	22.0	18.8	24.4
2030	15.4	20.4	16.8	22.2	19.2	24.9
2035	15.5	20.6	17.0	22.4	19.6	25.4
2040	15.6	20.7	17.2	22.6	20.0	25.8
2045	15.7	20.8	17.4	22.9	20.4	26.3
2050	15.8	20.9	17.5	23.1	20.9	26.8
2055	15.9	21.1	17.7	23.3	21.3	27.2
2060	16.0	21.2	17.9	23.6	21.7	27.7
2065	16.1	21.3	18.1	23.8	22.1	28.2
2070	16.2	21.5	18.3	24.0	22.5	28.6
2075	16.3	21.6	18.5	24.3	23.0	29.1
2080	16.4	21.7	18.7	24.5	23.4	29.6

Note: The life expectancy is the average number of years of life remaining to a person if he were to experience the age-specific mortality rates for the tabulated year throughout the remainder of his life.

Table 4. Aged Dependency Ratio and OASDI Cost Rate by Alternative and Mortality Assumption

Assumption	Aged Dependency Ratio in 2060 1/	1983-2057 OASDI Average Cost Rate 2/
1983 OASDI Trustees Report:		
Alternative I	.257	9.81
Alternative II-B	.348	12.84
Alternative III	.553	16.56
Alternative II-B except:		
No Mortality Improvement		
Alternative I Mortality	.305	12.18
Alternative II-B Mortality	.348	12.84
Alternative III Mortality	.424	13.81
Continuation of Recent Mortality Improvement		

1/ The aged dependency ratio is defined as the number of persons above the OASDI normal retirement age, which is 67 in 2060, divided by the number of persons aged 20 up to the OASDI normal retirement age. In 1983, the normal retirement age is 65 and the aged dependency ratio is .200.

2/ The OASDI cost rate for any year is the total outgo of the OASDI program expressed as a percentage of taxable payroll.

Senator CHAFEE. You have a very optimistic presentation here, Mr. Bayo, but I am not sure that I agree with it, I think you used the term in here 0.97 percent of payroll. To most people, 0.97 percent seems like a very modest amount, nothing to get terribly excited over, but what does that translate into dollars a year paying out under the social security system, if it is a change of 0.97 percent?

Mr. BAYO. It would be about $15 billion a year by 1985 or 1986.

Senator CHAFEE. $15 billion. And as I understand it the reserves of the social security program are in the neighborhood of $15 billion; are they not?

[Answers to questions from Senator Chafee:]

QUESTION FOR MR. BAYO

1. You may state on pages 20–21 that if the mortality element of your intermediate (II) projection were changed to reflect a more optimistic (by optimistic, I mean longer-lived) view of mortality as in Alternative III, the projected long-range cost to the Social Security Trust Funds (OASDI) would increase by "only" 0.97 percent of taxable payroll.

Now this sounds very calming, very reassuring.

But I would like to know how 0.97 percent translates into dollars—either for one year or over the long range? And what if the low mortality (Estimate III) proved to be too low? Do you have this percentage translated into dollars?

(Note.—The taxable payroll in 1983 is about $1.5 trillion, meaning that an increase in cost of 1 percent of payroll is equal to $15 billion per year?)

ANSWER TO QUESTION 1

The taxable payroll in 1983 is estimated at about $1,475 billion. Therefore, an increase in cost of 0.97 percent of payroll would equal $14 billion in 1983.

Mr. BAYO. A little bit higher than that. Not much.

Senator CHAFEE. How did we get this figure? Did we not have the figure $14 billion?

When we were considering in the short-range situation, that is, prior to 1992, right in that area, we were looking at reserves of $15 billion to $20 billion, and here a change of 0.97 percent is $18 billion, so we are talking some significant dollars. That is the point I am making.

Mr. BAYO. In terms of dollars, they are significant, Mr. Chairman.

Senator CHAFEE. So when one talks of 0.97 percent, which seems—which does not affect many things significantly, 0.97 percent in this program means a very, very large sum of money, and indeed could significantly affect the viability of the system, could it not?

Mr. BAYO. Yes, sir. Yes, Mr. Chairman. I was more looking at it from the point of view of the accuracy of the cost estimate. I wish we were only off by 1 percent in the 75-year projection, which means I will be off by 7 percent relatively of the cost being quoted.

Senator CHAFEE. I agree with you. I am just looking at it from an observer's point of view that the improvements for the young, as far as improving their life expectancy are probably modest that we can expect because of the control of the infectious diseases that we have reached to date, but it seems to me that the improvements for the aged—I agree with you where you say on page 16—are expected to continue at a relatively rapid pace as further strides are

made against degenerative diseases. The whole control of smoking, the better exercise, the better nutrition. So this is the group that obviously affects your system.

It seems to me, if somebody reaches the age of 75 now, the chances of them reaching the age of 80 are very, very good. Do you have any statistics on that, what the life expectancy of somebody who reaches the age of 75 is?

Mr. BAYO. Mr. Wilkin, do you have these?

We will have the figures in just a second, Mr. Chairman. Currently, 70 percent of males aged 75 live to age 80, and about 82 percent of females aged 75 live to age 80. The idea that I was trying to convey is that mortality does not change very quickly, that there will be ample time in which to take a look at the changing trends. Even if we were able to conquer some of the strongest killers that we have at the older ages, we will not be able to implement it that quickly. It takes a few years to get new discoveries to be applied and to save people.

Senator CHAFEE. Let us take on page 21 of your testimony where you say that the intermediate projections assume that the recent trends in mortality continue for a few more years and then decelerate to lower rates by the year 2007. In the 50 years thereafter, I understand, you assume mortality is to improve at only about a third of the rate experienced since 1900, and at about only a fifth of the rate experienced since 1968.

QUESTION FOR MR. BAYO

2. On page 21 you say that the intermediate (II) projections assume that the recent trends in mortality continue for a few more years then decelerate to slower rates by the year 2007. In the 50 years thereafter, I understand that you assume mortality is assumed to improve at only about a third of the rate experienced since 1900, and is only about a fifth of the rate experienced since 1968. Now, to a layman, your current intermediate projections seem awfully unrealistic just in terms of the historical record. Could you elaborate? Why, for example, would you estimate such a drop of mortality improvement at about the turn of the century, just as one might expect we could be making major breakthroughs against disease?

ANSWER TO QUESTION 2

A good projection cannot just extrapolate historical trends, especially something like declines in mortality. Consideration must be given to the reasons for past declines and the likelihood of future declines. Even the choice of the trends to be projected has a significant effect on the result. For example, projecting the recent (1968 to 1978) rapid rate of decline by age and sex to continue indefinitely, while disregarding the causes of death, would result in the life expectancy at birth increasing from 73.6 years in 1980 to 92.5 years in 2060. This would result in an increase of about 2 percent of payroll in the long-range OASDI average cost. However, projecting in a similar manner by cause and sex, while disregarding age (as was done by Professor Eileen Crimmins), results in a life expectancy at birth of only 85.1 years in 2060, and an increase in the long-range OASDI average cost of about 1 percent of payroll. The reason for the difference is that although recent data show declines in all age groups, it does not show declines in all causes of death; cancer shows an increase in mortality. When projecting by cause, the effect of the continued increases in the death from cancer eventually overpowers the declines in all other causes and the projected life expectancy will actually begin to decrease.

It must be remembered that a projection of continuously declining death rates implicitly assumes a continuous stream of breakthroughs in the control of disease and of the aging process. Because most of the infectious diseases, which were the major causes of death for persons under age 65, are already under control, little mortality improvement can be expected for these ages (with the exception of the ages affected by diseases of infancy). Therefore, it should be expected that when the projected mortality declines are combined over all ages the overall total would be lower than

in the past. For ages 65 and over, our current Alternative II assumptions result in a decline in mortality from 1980 to 2060 that is 123 percent and 77 percent of the decline from 1900 to 1980 for males and females, respectively. Although recent rates of improvement have been more rapid than the average since 1900, the historical data show that rates of decline in mortality have fluctuated in the past and also that the current rates of decline for the 65 and over are unprecedented. A continuation of this recent trend for the next 100 years seems highly unlikely.

QUESTION FOR MR. BAYO

3. On page 5 you suggest that changes in mortality affect Social Security costs but slowly, and thus there is ample time to consider whether program changes are necessary. Very calming.

I wonder, Mr. Bayo, how closely you followed this Committee's two-year struggle to reach agreement on the Social Security salvation package? Significant changes—such as changes in the retirement age—are very difficult and can only occur with plenty of advance notice.

Wouldn't it be better to represent conservative estimates of mortality that would, if wrong, provide a happy margin of safety for these critical programs?

ANSWER TO QUESTION 3

Some actuaries would agree that if they were responsible for the funding, they would provide estimates with a built-in level of conservativism, at least for private plans. However, the funding of the Social Security program is quite another matter. Congress is responsible for the funding of Social Security, and it would be presumptuous of the actuary to conceal from Congress a safety margin that has been added to the best estimate. This is particularly so in a subject as technical and specialized as mortality projections. If specifically requested I would be glad to provide the Congress with conservative estimates. In the meantime I interpret my principal responsibility as providing my best estimate.

QUESTION FOR MR. BAYO

4. It is also calming to predict a future in which mortality rates, particularly in the over 65 group, are static (as you stress on page 4). But as Dr. Brody points out (on page 2, second paragraph) we have been quite surprised by the very rapid drop in mortality in this group from 1920 to 1945. How different our planning would have been could we have forecast this phenomenon.

Wouldn't you agree with Dr. Brody (page 4) that we should use all the improving techniques of data gathering and analysis and combine epidemiologic methods with the actuarial techniques you now rely on? For example, have you factored into your estimates the correlation between education and increased longevity?

It seems to me that the stakes are very large in using the best available methods. Are you convinced you are doing so?

ANSWER TO QUESTION 4

In the interest of simplicity, on page of the written statement I stressed that of all the assumptions needed for cost projections the mortality rates are the most stable. However, this does not mean that they do not change, but only that their rate of decline is much steadier. Because we project mortality to decline in the near future at rates close to the recent rates of decline, it would take several years of actual declines at rates significantly different from the recent past before the level of mortality would be significantly different from what we projected. It would take several more years after that before the size of the actual population over age 65 was significantly different from what we projected. In Table 4 of my statement we show the cost effect of assuming mortality rates static at their 1982 levels. It should be understood that this projection is illustrative, just as that of Professor Crimmins which was based on a continuation of recent trends indefinitely. These two projections may be considered the extremes between which reasonable projections should fall. Table 4 shows that the estimated long-range OASDI cost rate under Alternative II-B would be lower by 1.18 percent if mortality were not projected to improve, and higher by about 1 percent of payroll if mortality were projected to continue at the recent rate of decline by cause and sex.

Naturally we agree that we should use the best projection techniques possible. I would like to mention that the Office of the Actuary is the only group of people that we know of in the United States who annually produce mortality projections, widely distribute the results, and invite comment from the general public. As such, we are

recognized experts in the field, and obviously we are often criticized by various groups and individuals both for projecting mortality to decline too rapidly and too slowly. We will continue to gather more data and do more analysis to improve our projections.

We are limited by our small staff as to the number of epidemiological or correlation studies that we can do, but we do try to stay abreast of the current literature for practical improvement to our work. The new data and methods could help in trying to predict what will happen in the near future, but it should be recognized that there is usually just as much uncertainty about the future path of these correlated variables as there is about the overall mortality itself. It would be foolhardy to start comprehensive and costly programs of data gathering and analysis with the expectation of making significant improvement on our knowledge of what will happen up to 75 years in the future.

Mr. BAYO. That is true, Mr. Chairman, with respect to the entire population, because there is not much improvement that could be made at the younger ages. But for the aged, those 65 and over, our assumption is that the rate of decline for 1980–2060 will be about 42 percent of what we have had in the last 10 years, and very close to what we have had since the turn of the century.

Senator CHAFEE. Could you repeat that please?

Mr. BAYO. After the year 2007, the assumption that we have is that mortality will decrease at about one-third of the rate that it has been decreasing since the turn of the century. That is for the entire population. When we limit ourselves to the aged, our improvement is projected to be higher.

Senator CHAFEE. Now I am confused. You expect mortality, to improve at only about a third of the rate experienced since 1900, and only about one-fifth of the rate experienced since 1968. These are your post-2007 projections. Is that correct?

Mr. BAYO. That is correct for the whole population of the United States, but most of the cost of the program is related to the aged, and for the aged we assume higher increases. In other words, we have different assumptions. For younger, there is not much improvement that can be obtained.

Senator CHAFEE. How do those statistics compare for the experience of the aged from, say, 1968 on?

Mr. BAYO. For the next 80 years, we assume under the intermediate assumption that the mortality for the aged will be about 90 percent of what we have had in the last 80 years.

Senator CHAFEE. What do you base that on?

Mr. BAYO. For the next 80, it is about 90 percent of what we had in the last 80.

Senator CHAFEE. And that is where we differ, the only difference being you have got experience and a host of statisticians helping you. But it just seems to me that people are living a lot, lot longer, and that trend is accelerating. You do not agree with that?

Mr. BAYO. Well, the thing is, where are those improvements in mortality going to come from? That is the problem that we have. We are now conquering the cardiovascular and renal diseases, but we have not been able to do much about cancer.

Senator CHAFEE. Well, I do not see why you expect these improvements to decrease. If you had been sitting here in 1968, you would have never anticipated just the changes in lifestyles that have come about.

Mr. BAYO. That is correct. The mortality since 1968 has been decreasing very fast. But I doubt that that pace of improvement can be sustained for a long period of time.

Senator CHAFEE. But the ramifications, if you are wrong, are very significant. You say you have got plenty of time. There is no rush in these things. But making changes in the social security system is very, very difficult for Congress to do, and we have to have lots of warning. It is a program that cannot be changed quickly. We went through this painful process last year and this year. So why do you say that you have got plenty of time?

Mr. BAYO. We will have plenty of time because mortality decreases 2 or 3 percent per year at the most, and the costs will not be affected by 2 or 3 percent per year either. For example, let us assume that the mortality of the aged is about 5 percent per year, all of the ages taken together. So that means that of 1,000 beneficiaries, 950 will survive 1 year. With decreasing mortality by a very large amount, like 10 percent, that means that the mortality will go from 5 percent to 4.5 percent. It also means that instead of having 950 survivors, we have 955 survivors. So the effect on the program is going to be about half a percent increase in the cost in that year, and it will be a while before it would be large enough to require drastic changes in a program that is supposed to last many years into the future.

I believe that the best approach for the Congress is to wait until we have a definite trend that is generally agreed upon, and then recognize that trend.

Senator CHAFEE. We have a definite trend.

Mr. BAYO. We have a definite trend and we have recognized it, Mr. Chairman. We are recognizing what we have had. In the near future we assume the trend is going to continue, we project to continue at that level of improvement.

Senator CHAFEE. Is it my understanding that within 10 years you have had at least two major revisions of your life expectancy projections?

Mr. BAYO. We have had more than two. We have had four. In 1977, 1978, 1979, and 1980.

Senator CHAFEE. And have they always been upward?

Mr. BAYO. With respect to mortality, yes.

Senator CHAFEE. I just think that you are overly sanguine, and—excuse me.

[Whereupon, a brief recess was taken.]

Senator CHAFEE. Now, if Dr. Brody could come to the table, and if you could remain there, Mr. Bayo, why do we not hear from Dr. Brody, and see how his testimony works out, and there may be some questions that I would have with you based on his testimony.

Doctor, we welcome you here. Dr. Brody is the associate director of the National Institute on Aging. You have a statement, I believe, Doctor.

STATEMENT OF JACOB A. BRODY, M.S., ASSOCIATE DIRECTOR, NATIONAL INSTITUTE ON AGING

Mr. BRODY. Yes, Mr. Chafee. I first wish to thank you and your staff for permitting me to speak here and more importantly for

opening the exploration of this very important area of projections, life expectancy, mortality rates, and lifespan.

Projection of overall mortality, including those who will be age 65 and over in the future, is the basic issue of our discussion, and a very complicated issue at that. It is my opinion that with increasing utilization of modern computer technology and access to more complete medical and social data, as well as the implementation of such new tools as the National Death Index, there is hope for substantial achievement through a meld of actuarial and epidemiologic approaches.

The epidemiologic approach is one in which health, illness, and related factors are studied in populations rather than in individual patients. The task of projecting the population is difficult from both a mathematical and a biological point of view. In order to make projections, the technique requires accurate information. This has proved to be elusive.

While the number of reported deaths in the United States is fairly reliable, the specific causes are not as accurate. Furthermore, in the 1980 census, there was an estimated undercount of approximately 5½ million persons. Data for those over aged 65, however, have improved remarkably, and at present medicare records and the death certificates show a concurrence approaching 100 percent.

Thus, for data relating to those 65 and over, we can be more comfortable in utilizing the epidemiologic information as well as the classical actuarial approaches which depend more heavily on fixed theoretical assumptions.

A review of age specific mortality figures for the United States during this century will illustrate the array of surprises which have occurred and suggest the degree of humility we must bring to future attempts at making projections.

Attached to my statement and also on this chart on the wall are two figures which I will address. In the upper figure, we show deaths from all causes for 1900 to 1979. The top line signifies males, the bottom line females, and the middle line the total population. As expected, females at all ages have lower age specific mortalities than males. A noteworthy element in this chart is that during the period shown, half the reduction in mortality occurred by 1920. This was during a period where the greatest changes were due to general conditions of living and sanitation rather than any spectacular medical or social breakthroughs.

In the bottom figure, the same time period is covered, but only for people aged 65 and over. In this figure, we see that the elderly themselves since 1900 are indeed living longer, a point we have already stressed repeatedly. Looking closely at the curves, we note that there was barely a 5-percent decline during the first 20 years of this century, the period in which half the decline occurred for the entire population.

By 1945 or so, half the decline in those aged 65 and over had been accomplished. This pattern of a plateau until 1920 and then a rapid decline by 1945 would be difficult to predict either from a theoretical or an empirical approach. This very large decline definitely occurred, but for reasons we just do not understand. Had we been aware of it during that period, we would have perhaps shaped

our initial approach to social security taxation and payments along different lines.

As we follow the curve for those aged 65 and over toward recent years, small differences become more important. This is because in 1900 only 25 percent of all deaths occurred in people 65 and over, while by 1979 70 percent of all deaths were occurring in this population of only 11 percent. The deceptive plateau following World War II, particularly when analyzed for all ages in the upper figure, caused us to assume that life expectancy had stabilized at a peak, and for a brief time projections made by any technique were easy.

Focusing again on the lower figure, we see that dramatic changes were taking place among those age 65 and over throughout this period, with a rise in mortality from the late 1950's until about 1968, and a rapid decline since that time. Please note that the decline in the elderly mortality is far greater than the curve for all ages, comparing the furthest right portion of both the upper and lower charts. This suggests that increases in longevity are occurring at a disproportionately high rate among the elderly. Thus, the oldest are increasing in their life expectancy the most.

It would be comforting to claim that we are the agents responsible for the decline in mortality since 1968 through our social and medical interventions. This is unlikely, however, since major reductions in smoking and in the use of antihypertensive drugs and surely dietary modification did not really exert powerful effects until the early to middle 1970's.

This suggests that a large proportion of the decline was really not readily explainable, and more important in terms of epidemiologic projections is that benefits from antihypertension medications or smoking cessation and many other interventions have not yet been fully maximized.

Senator CHAFEE. I could not agree with you more. Go ahead. You are singing my song.

Dr. BRODY. Areas where epidemiologic information can supplement actuarial approaches are numerous. To mention a few, we know that influenza has a particularly devastating effect on the older population. Thus there was an actual increase in mortality during 1980 and 1981, largely ascribed to influenza. We know that a greater proportion of our population will be older, and there are scientists who are doing better and better in creating computer models to predict influenza epidemics. By incorporating this type of information into future projections, we gain the richness of another factor which has marked effects on the population most susceptible to dying.

Another example is the well-documented observation that the level of education measured even apart from socioeconomic status has an extraordinary effect on longevity. The least educated die approximately 5 to 8 years earlier than the most educated in both the United States and Great Britain. Level of education represents an enormous influence on mortality, having more than twice the impact of cancer. The population now 65 and over has 2 to 3 years less education than those under age 65. During the next 25 years or so, the educational level of the 65 and over group will equal that of all adult age groups. It is likely that this change will be accompanied by a strong shift away from premature mortality and to in-

creased longevity as well, of course, as creating a larger and more articulate political subgroup.

To summarize, there is ample evidence that the forces which influence mortality are generally predictable, but specifically and for any given period of time are subject to substantial variations. Given this information, it behooves us to develop iterative approaches utilizing all the improving techniques for data gathering and analysis, and combine epidemiologic methods and actuarial techniques in establishing projections and their parameters.

Thank you again, Mr. Chairman. I would be pleased to try to answer any questions.

[The prepared statement of Dr. Brody follows:]

STATEMENT

BY

JACOB A. BRODY, M.D.

ASSOCIATE DIRECTOR FOR EPIDEMIOLOGY, DEMOGRAPHY, AND BIOMETRY PROGRAM

MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE:

PROJECTION OF OVERALL MORTALITY, INCLUDING THOSE WHO WILL BE AGE 65 AND OVER I THE FUTURE, IS THE BASIC ISSUE OF OUR DISCUSSION AND A VERY COMPLICATED ISSUE A THAT. IT IS MY OPINION THAT WITH INCREASING UTILIZATION OF MODERN COMPUTER TECHNOLOGY AND ACCESS TO MORE COMPLETE MEDICAL AND SOCIAL DATA, AS WELL AS THE IMPLEMENTATION OF SUCH NEW TOOLS AS THE NATIONAL DEATH INDEX, THERE IS HOPE FOR SUBSTANTIAL PROGRESS THROUGH A MELD OF ACTUARIAL AND EPIDEMIOLOGIC APPROACHES. THE EPIDEMIOLOGIC APPROACH IS ONE IN WHICH HEALTH, ILLNESS, AND RELATED FACTORS ARE STUDIED IN POPULATIONS RATHER THAN IN INDIVIDUAL PATIENTS.

THE TASK OF PROJECTING THE POPULATION IS DIFFICULT FROM BOTH A MATHEMATICAL AND BIOLOGICAL POINT OF VIEW. IN ORDER TO MAKE PROJECTIONS, ANY TECHNIQUE REQUIRES ACCURATE INFORMATION. THIS HAS PROVED TO BE ELUSIVE. WHILE THE NUMBER OF REPORTED DEATHS IN THE UNITED STATES IS FAIRLY RELIABLE, THE SPECIFIC CAUSES AR NOT AS ACCURATE. FURTHERMORE, IN THE 1980 CENSUS THERE IS AN ESTIMATED UNDERCOUNT OF APPROXIMATELY 5.5 MILLION PERSONS. DATA FOR THOSE 65 AND OVER, HOWEVER, HAVE IMPROVED REMARKABLY AND, AT PRESENT, THE MEDICARE ROLLS AND THE DEATH CERTIFICATES SHOW A CONCURRENCE APPROACHING 100 PERCENT. THUS, FOR DATA RELATING TO THOSE 65 AND OVER, WE CAN BE COMFORTABLE UTILIZING EPIDEMIOLOGIC INFORMATION AS WELL AS CLASSIC, ACTUARIAL APPROACHES WHICH DEPEND MORE HEAVILY ON FIXED, THEORETICAL ASSUMPTIONS. BESIDES ACCURATE DATA, WE NEED RELIABLE CONCEPTUAL MODELS OF FERTILITY AND MORTALITY RATE CHANGES, BOTH AREAS OF SUBSTANTIAL CONTROVERSY AND UNPREDICTABILITY.

A REVIEW OF AGE-SPECIFIC MORTALITY FIGURES FOR THE UNITED STATES, DURING THIS CENTURY, WILL ILLUSTRATE THE ARRAY OF SURPRISES WHICH HAVE OCCURRED AND SUGGES THE DEGREE OF HUMILITY WE MUST BRING TO FUTURE ATTEMPTS AT MAKING PROJECTIONS. ON THE FIRST FIGURE WE SHOW DEATHS FOR ALL AGES FROM 1900 TO 1979. THE TOP LI

SIGNIFIES MALES, THE BOTTOM LINE, FEMALES AND THE MIDDLE LINE, THE TOTAL POPULATION. AS EXPECTED, FEMALES AT ALL AGES HAVE A LOWER AGE-SPECIFIC MORTALITY THAN MALES. A NOTEWORTHY ELEMENT IN THIS CHART IS THAT, DURING THE PERIOD SHOWN, HALF THE REDUCTION IN MORTALITY OCCURRED BY ABOUT 1920. THIS WAS DURING A PERIOD WHERE THE GREATEST CHANGES WERE DUE TO IMPROVED GENERAL CONDITIONS OF LIVING AND IN SANITATION RATHER THAN ANY SPECTACULAR MEDICAL OR SOCIAL BREAKTHROUGHS.

IN THE SECOND FIGURE THE SAME TIME PERIOD IS COVERED, BUT ONLY FOR PEOPLE AGE 65 AND OVER. IN THIS FIGURE, WE SEE THAT, SINCE AT LEAST 1900, THE ELDERLY THEMSELVES ARE CLEARLY LIVING LONGER. LOOKING CLOSELY AT THE CURVES, WE NOTE THAT THERE WAS BARELY A 5 PERCENT DECLINE IN DEATHS DURING THE FIRST 20 YEARS OF THE CENTURY, THE PERIOD IN WHICH HALF THE DECLINE OCCURRED FOR THE ENTIRE POPULATION. BY 1945 OR SO, HALF THE DECLINE IN THOSE AGE 65 AND OVER HAD BEEN ACCOMPLISHED. THIS PATTERN OF A PLATEAU UNTIL 1920 AND THEN A RAPID DECLINE BY 1945 WOULD BE DIFFICULT TO PREDICT EITHER FROM A THEORETICAL OR EMPIRICAL APPROACH. THIS VERY LARGE DECLINE DEFINITELY OCCURRED, BUT FOR REASONS WHICH WE DO NOT UNDERSTAND. HAD WE BEEN AWARE OF IT DURING THAT PERIOD, WE WOULD HAVE PERHAPS SHAPED OUR INITIAL APPROACH TO SOCIAL SECURITY TAXATION AND PAYMENTS ALONG DIFFERENT LINES.

AS WE FOLLOW THIS CURVE FOR THOSE 65 AND OVER TOWARD RECENT YEARS, SMALL DIFFERENCES BECOME MORE IMPORTANT. THIS IS BECAUSE IN 1900 ONLY ABOUT 25 PERCENT OF DEATHS OCCURRED IN THOSE 65 AND OVER, WHILE BY 1979 ABOUT 70 PERCENT OF ALL DEATHS WERE OCCURRING IN THIS SUBPOPULATION OF ONLY 11 PERCENT. THE DECEPTIVE PLATEAU FOLLOWING WORLD WAR II, PARTICULARLY WHEN ANALYZED FOR ALL AGES (IN FIGURE 1), CAUSED US TO ASSUME THAT LIFE EXPECTANCY HAD STABILIZED AT A PEAK, AND FOR A BRIEF TIME, PROJECTIONS MADE BY ANY TECHNIQUE WERE ACCURATE.

FOCUSING AGAIN ON THE SECOND FIGURE, WE SEE THAT LARGE, DRAMATIC CHANGES WERE TAKING PLACE AMONG THOSE AGE 65 AND OVER THROUGHOUT THIS PERIOD WITH A RISE IN MORTALITY FROM THE LATE 1950'S UNTIL ABOUT 1968, AND A RAPID DECLINE SINCE THAT TIME. PLEASE NOTE THAT THIS DECLINE IN ELDERLY MORTALITY IS FAR GREATER THAN IN THE CURVE FOR THOSE OF ALL AGES, SUGGESTING THAT INCREASES IN LONGEVITY ARE OCCURRING AT A DISPROPORTIONATELY HIGH RATE AMONG THE ELDERLY. THUS, THE OLDEST ARE INCREASING THEIR LIFE EXPECTANCY THE MOST.

IT WOULD BE COMFORTING TO CLAIM THAT WE ARE THE AGENTS RESPONSIBLE FOR THE DECLINE IN MORTALITY SINCE 1968 THROUGH OUR SOCIAL AND MEDICAL INTERVENTIONS. THIS IS UNLIKELY, HOWEVER, SINCE MAJOR REDUCTIONS IN SMOKING AND IN THE USE OF ANTI-HYPERTENSIVE DRUGS AND, SURELY, IN DIETARY MODIFICATION DID NOT REALLY EXERT POWERFUL EFFECTS UNTIL THE EARLY TO MIDDLE 1970'S. THIS SUGGESTS THAT A LARGE PROPORTION OF THE DECLINE IS REALLY NOT READILY EXPLAINED AND, MORE IMPORTANT, IN TERMS OF EPIDEMIOLOGIC PROJECTIONS, IS THAT BENEFITS FROM ANTI-HYPERTENSIVE MEDICATIONS AND SMOKING CESSATION HAVE NOT YET BEEN MAXIMALLY REALIZED.

AREAS WHERE EPIDEMIOLOGIC INFORMATION CAN SUPPLEMENT ACTUARIAL APPROACHES ARE NUMEROUS. TO MENTION A FEW, WE KNOW THAT INFLUENZA HAS A PARTICULARLY DEVASTATING EFFECT ON THE OLDER POPULATION. THUS, THERE WAS AN ACTUAL INCREASE IN MORTALITY DURING 1980 AND 1981 LARGELY ASCRIBED TO INFLUENZA. WE KNOW THAT A GREATER PROPORTION OF OUR POPULATION WILL BE OLDER, AND THERE ARE SCIENTISTS WHO ARE DOING BETTER AND BETTER IN CREATING COMPUTER MODELS OF THE PATTERNS OF INFLUENZA EPIDEMICS AND PANDEMICS (WORLD-WIDE EPIDEMIC). BY INCORPORATING THIS TYPE OF INFORMATION INTO FUTURE PROJECTIONS WE GAIN THE RICHNESS OF ANOTHER APPROACH WHICH HAS MARKED EFFECTS ON THE POPULATION MOST SUSCEPTIBLE TO DYING.

ANOTHER EXAMPLE IS THE WELL-DOCUMENTED OBSERVATION THAT LEVEL OF EDUCATION, MEASURED EVEN APART FROM SOCIOECONOMIC STATUS HAS AN EXTRAORDINARY EFFECT ON LONGEVITY. THE LEAST-EDUCATED DIE APPROXIMATELY 5 TO 8 YEARS EARLIER THAN THE MOST-EDUCATED IN BOTH THE UNITED STATES AND GREAT BRITAIN. LEVEL OF EDUCATION REPRESENTS AN ENORMOUS INFLUENCE ON MORTALITY, HAVING MORE THAN TWICE THE IMPACT OF CANCER. THE POPULATION NOW 65 AND OVER, HAS 2 TO 3 YEARS LESS EDUCATION THAN THOSE UNDER AGE 65. DURING THE NEXT 25 YEARS OR SO, THE EDUCATIONAL LEVEL OF THE 65 AND OVER GROUP WILL EQUAL ALL OTHER ADULT AGE GROUPS. IT IS LIKELY THAT THIS CHANGE WILL BE ACCOMPANIED BY A STRONG SHIFT AWAY FROM PREMATURE MORTALITY, AND HENCE, INCREASED LONGEVITY, AS WELL, OF COURSE, AS CREATING A LARGER AND MORE ARTICULATE POLITICAL SUBGROUP.

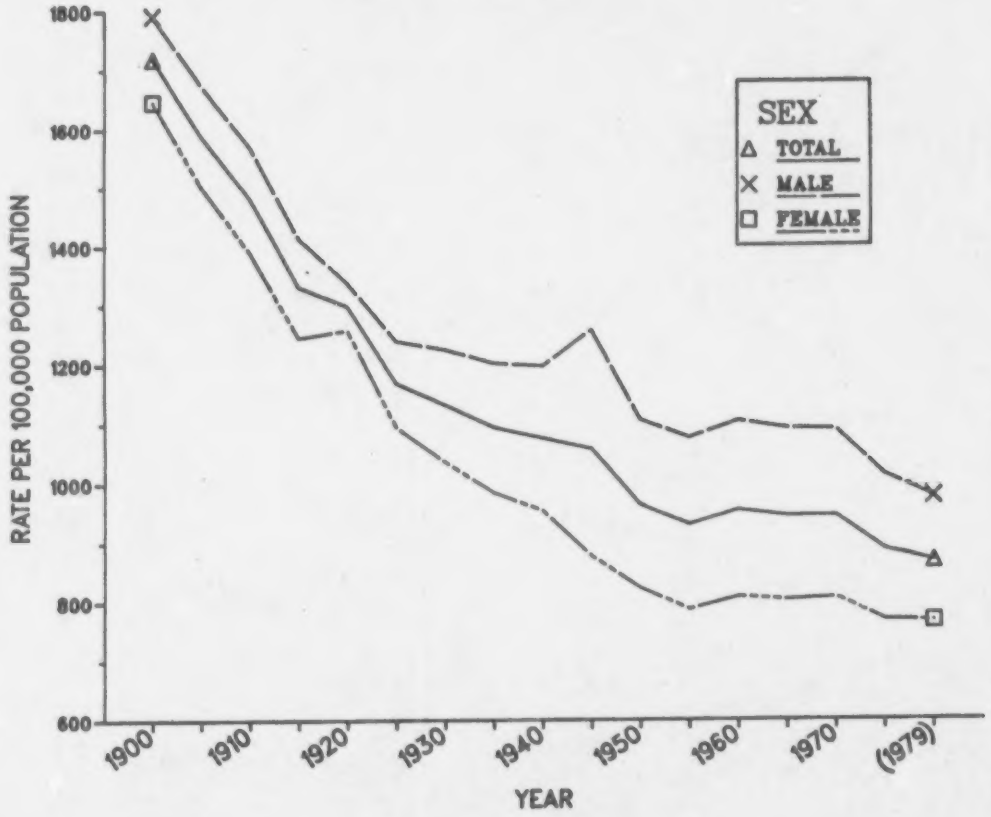
TO SUMMARIZE, THERE IS AMPLE EVIDENCE THAT THE FORCES WHICH INFLUENCE MORTALITY ARE GENERALLY PREDICTABLE, BUT SPECIFICALLY, AND FOR ANY GIVEN PERIOD OF TIME, ARE SUBJECT TO SUBSTANTIAL VARIATIONS. GIVEN THIS INFORMATION, IT BEHOOVES US TO DEVELOP ITERATIVE APPROACHES UTILIZING ALL THE IMPROVING TECHNIQUES OF DATA GATHERING AND ANALYSIS AND COMBINE EPIDEMIOLOGIC METHODS WITH ACTUARIAL TECHNIQUES IN ESTABLISHING PROJECTIONS AND THEIR PARAMETERS.

EPIDEMIOLOGIC INFORMATION COLLECTED FROM ELDERLY POPULATIONS READILY DEMONSTRATES THAT ILLNESSES REQUIRING GREAT EXPENDITURES AND LONG-TERM CARE RISE STEEPLY AFTER AGE 75. WITHIN THE NEXT 10 TO 15 YEARS, ALMOST 50 PERCENT OF THOSE OVER AGE 65 WILL BE OVER AGE 75. THUS, WE CAN PROJECT THAT THE NECESSARY MEDICAL COSTS FOR THE POPULATION SERVED BY MEDICARE AND SOCIAL SECURITY WILL BE MUCH HIGHER THAN AT PRESENT. USING THE MOST ACCURATE DATA AVAILABLE ON CHRONIC CONDITIONS IN THE ELDERLY, WE CAN BETTER APPROACH THE INEVITABLE HEALTH NEEDS OF THIS AGE SEGMENT.

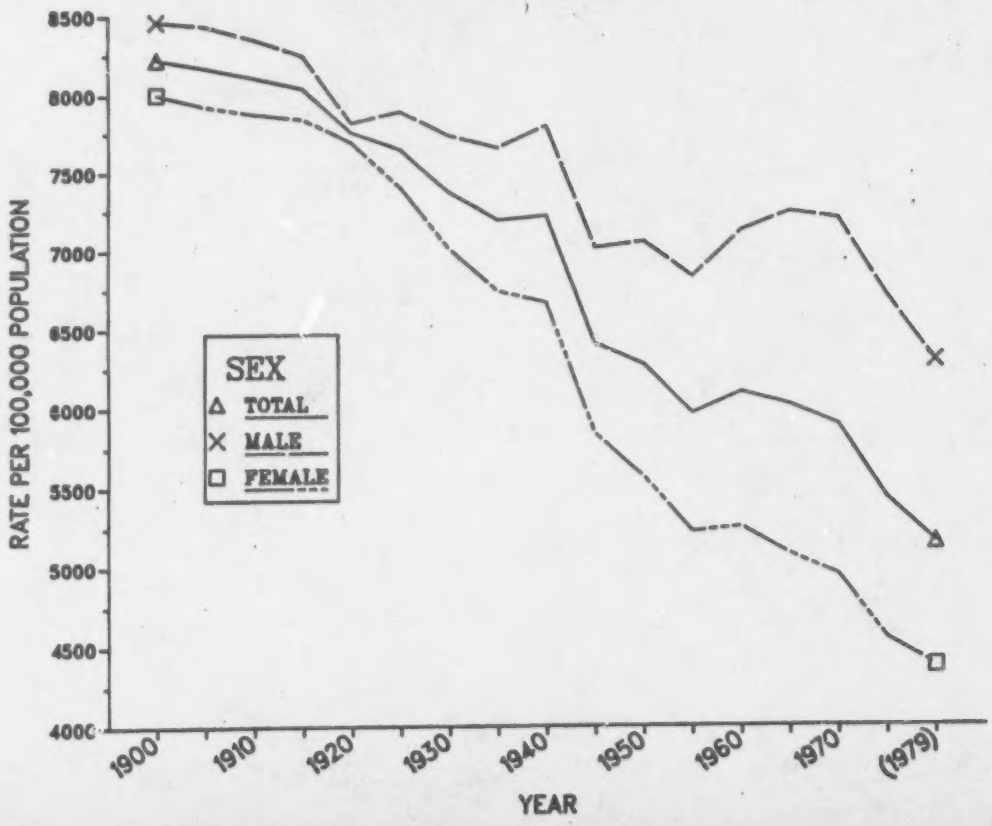
THE NATIONAL INSTITUTE ON AGING HAS DEVELOPED A MACROECONOMIC-DEMOGRAPHIC MODEL (MDM) WHICH UTILIZES A POPULATION MODEL COMBINED WITH ADDITIONAL SECTORS TO PROJECT THE ECONOMY, LABOR MARKET, SOCIAL SECURITY AND PRIVATE PENSIONS, AND MEDICARE EXPENDITURES. ADDITIONAL RESEARCH HAS BEGUN ON LONG-TERM ASPECTS OF HEALTH EXPENDITURES, UTILIZATION, AND HEALTH STATUS. ALTHOUGH OUR STAFF OF EPIDEMIOLOGISTS, ECONOMISTS, BIOSTATISTICIANS, AND SOCIAL SCIENTISTS IS SMALL WE CAN CLAIM SOME USEFUL PROGRESS IN MULTIDISCIPLINARY RESEARCH ON POPULATION AGING. SUCCESS, HOWEVER, IS SLOW IN COMING AND THE TASK IS FORMIDABLE.

THANK YOU, MR. CHAIRMAN. I WOULD BE PLEASED TO TRY TO ANSWER ANY QUESTIONS YOU MAY HAVE.

MORTALITY RATES FOR YEARS 1900–1979, BY SEX (ALL AGES)



MORTALITY RATES FOR YEARS 1900–1979, BY SEX (AGES 65 AND OVER)



Senator CHAFEE. Well, thank you very much, Doctor. I find that very interesting. Is there any information we can gain from other societies that might be helpful? You mentioned the fact that in Britain they have also found that increased education results in, I think, you said an additional 4 years of longevity. What about in Sweden or Japan?

Dr. BRODY. I think certainly Sweden and Japan offer us very important lessons. In both Sweden and Japan, for instance, heart disease mortality is increasing. It is decreasing in the United States, and certainly is the cause for part of our recent life extension. We can see, however, that if heart disease is increasing in other countries in which they are also having major increases in life expectancy, there are bound to be other forces which will drive life expectancy even higher.

What I am saying is that by contrasting the experience in these countries, which are all increasing in life expectancy, it appears that there are many forces which we are not aware of or in control of that will increase life expectancy in the future.

Senator CHAFEE. Dr. Bayo mentioned in his testimony the fact that the changing lifestyles for women will probably influence the life expectancy of women in the future. They are going into the market-place and being subjected to the stresses, presumably, that men have been subjected to.

Do you think there is much to that?

Dr. BRODY. This is certainly a factor, a strong factor. Women are not only in the marketplace but are smoking more and drinking more, which is going to compromise their life expectancy.

On the other hand, there seem to be other strong forces afoot as well, so that in countries in which women have been in the marketplace for many years, such as in Sweden, where the life expectancy for women is still comfortably ahead of males and increasing, although not at the same high rate as in the United States. In general, the female survival advantage is increasing.

Senator CHAFEE. In your testimony you said on the first page, "the array of surprises which have occurred and the degree of humility we must bring to future attempts at making projections." Is it safe to say that the surprises always stem from increased longevity?

Dr. BRODY. During the century, for the most part they have been. However, there were surprises in the opposite direction, which I mentioned in 1980 and 1981 from influenza, and on the data in the curve I showed, from 1950 to 1968 for the elderly there were increases in morality. So, concerning the surprises, while the major thrust was toward an increase in longevity, there are mitigating—I do not know if mitigating is the right word—there are contrary surprises.

Senator CHAFEE. In your conclusion you suggest that we must be alert and try to assemble our information and correlate it. Are there two or three important steps you think we should take to improve life expectancy projections?

Dr. BRODY. I think a most hopeful one is at hand in gaining new types of access to data which are already available in different large Federal data sets. This would be in the social security system, in the IRS, in medicare data itself, the National Death Index, and

large studies conducted by the National Center for Health Statistics and the National Center for Health Services Research and other, nongovernmental and, of course, Government agencies.

These data are being used for very specific purposes but not being linked to learn the maximum from the potential that exists in them. There are some very minor limitations because of privacy legislation. I think these limitations could be overcome with the proper presentation of the cost and scientific benefits that would result from linking already existing data.

Senator CHAFEE. Do you think the Social Security Administration is sufficiently taking into account the forces that are at work now that you mentioned?

Dr. BRODY. It is very difficult for me to get a firm feeling for that. I think I could easily argue that they are not because nobody has spoken to me, but what I really want to say is that there is a limit to the number of data variables they can handle. There is a limit to the number of adjustments you can make in any given model.

I do think, however—as I have tried to present in my statement—that there are very strong and positive areas in the field of biomedical work, certainly at the National Center for Health Statistics and NIH, which I think could be made available to Social Security that are not currently being used.

Senator CHAFEE. What do you say to that, Doctor Bayo?

Mr. BAYO. I agree that we could and that we should continue to extend the research in mortality and particularly determine or try to find out what has been causing the recent fast trend in decline in mortality. This, I think, is a very useful in the projection of mortality into the near future.

As I said in my statement, when you go 75 years into the future, it is very difficult to base it on what has happened recently. After 20 or 25 years we are really in an area that is unknown and possibly with very little relation to what has happened in the last 10 years.

Senator CHAFEE. It seems to me that you could say that about anything. Any projection is difficult for the future and you can always say that you cannot go by what has taken place in the past, but that gives you a pretty good indication.

Let me ask you this, Dr. Brody. You mentioned that the census in 1980 was probably under by, I think you said, 5.5 million. I suppose that these 5.5 million were, for the most part illegal aliens and Spanish Americans would you think?

Dr. BRODY. It is my understanding that that is apart from the illegal aliens, for which there is another estimate. I think Mr. Bayo would know this better than me.

Senator CHAFEE. Do you know, Mr. Bayo?

Mr. BAYO. Mr. Chairman, is it a question with respect to the undercount in the census?

Senator CHAFEE. Yes.

Mr. BAYO. There are several reasons why we have an undercount in the census. It is almost impossible, really, to knock on every door and find every individual there, and so I would say that the majority of it is not related to illegal aliens. There has been tre-

mendous improvement in the level of coverage, but we should expect that there will always be a certain level of net undercount.

Senator CHAFEE. Yes, I would expect that. But what is the effect on the life expectancy as a result of the very substantial increase of Spanish Americans in our society? Is that going to affect it one way or the other?

Mr. BAYO. It will affect it definitely because it is expected that the mortality of the Spanish American will be higher than that of the rest of the population. The question is, by how much and what will be the level. We have 235 million people and 10 percent of the population, at the most, could be included in the Spanish American [that] group. The difference in mortality, although significant, would have little affect on future mortality trends.

I do not know whether that will have that much of an effect in the projections.

Senator CHAFEE. Well, thank you both very much for coming. We appreciate it. You have been very helpful. Thank you, Mr. Bayo, Dr. Brody, and Mr. Wilkin.

[Questions and answers submitted to Dr. Brody follows:]

QUESTIONS FOR DR. BRODY

1. Fundamentally, Dr. Brody, I think we want to know how to develop the best possible projections of life expectancy and mortality. We need to know this—not just for Social Security/Medicare planning—but for many reasons.

Tell me what you think are the 2 or 3 most important steps we should take to improve life expectancy projections by both the government and the private sector? What should we do?

Answer. Among the most important steps to improve life expectancy projections is the better utilization of already collected and existing data which I referred to on page 34, lines 9 to 22. Another is the meld of actuarial and epidemiologic approaches referred to on page 26, lines 15 to 16. This would involve a careful review of available data to determine the most realistic assumptions for future central or intermediate projections as well as the range of error now encompassed in the high and low projections. Epidemiologic and biomedical input should be organized through the Directors of NIH and NCHS. They, in turn, would have access to other federal agencies, state and academic expertise as well as major private sector authorities in the spectrum of fields related to long-term care of the elderly. By involving biomedical thinking we could improve on the currently used assumptions driving the Social Security actuarial model.

2. Dr. Brody, I take it that you do not believe that the current actuarial work of the Social Security Administration sufficiently takes into account the forces at work in the scientific community, and in the society (such as increased education). How should this situation be corrected?

Answer. As discussed in my response to the previous question, we must have epidemiologic and related biomedical and social input monitoring events which have important effects on life expectancy. I have mentioned influenza and levels of education. In addition, we must have measures of available family and household support as well as a better surveillance mechanism for disease-specific mortality. We must learn the causes of the massive decline in heart disease mortality in the United States and how we can influence its continuate decline.

3. Do you agree with the Social Security Administration's intermediate projections for mortality for the next 80 years? Do these projections seem plausible?

Answer. I am not personally comfortable with the Social Security Administration's intermediate projections for the next 80 years. During the next 20 years I believe the low mortality projection is more likely to occur. As I stated on page 29, lines 19 to 23, the real gains from recent medical and social interventions have not been maximized. Further, increased educational levels (page 39, lines 23 to 25) will increase life expectancy. I agree with the Social Security Actuaries that projections beyond 20 years or so become increasingly problematic. After 2005 the Social Security Administration measures change by using a theoretical "ultimate annual percentage improvement." While this provides a mathematical basis for projections to an infinite age, it must ignore the physiologic reality that life span is finite. Cur-

rently life span for the human species is about 110 years. Breakthroughs or manipulations could alter life span, but whether this will happen, and, if the increase will be gradual or slow, and how many additonal years the human species could survive, are even woollier concepts than the "ultimate annual percentage improvement." I believe some extension of life span is probable and I also believe that new diseases (such as AIDS—acquired immune deficiency syndrome) and inevitable events such as major influenza epidemics could shorten life expectancy. I sugggest that through increasing use of the National Death Index of NCHS and Medicare population records we will be able to monitor mortality rapidly and precisely. Short-term projections would be empirical and long-term projections would increasingly based on accumulated actual experience.

4. Are there alternatives to actuarial approaches in making mortality projections?

Answer. I believe that some actuarial approach is necessary and desirable but that we must increasingly use empirical, epidemiologic input. This requires a strengthening of data and data access and an approach outlined in the last two sentences of my response to question No. 3.

5. I understand that in other industrial countries life expectancy is increasing dramatically, but for quite different reasons. Are there any lessions in this experience for us?

Answer. Yes. I would reiterate my response to Senator Chafee's question on page 32. Great research potential toward understanding and improving healthy longevity exists by studying the different and occasionally contradictory appearing patterns by which life expectancy has increased in the United States and in other countries.

Senator CHAFEE. Now, the next panel—Dr. Manton, Dr. Keyfitz, and Dr. Walford—if each of you would please come up. All right, now. Dr. Walford we know—why do we not start with Dr. Manton?

STATEMENT OF KENNETH G. MANTON, PH. D., ASSOCIATE RESEARCH PROFESSOR, CENTER FOR DEMOGRAPHIC STUDIES, DUKE UNIVERSITY, DURHAM, N.C.

Mr. MANTON. Thank you.

The broad range of financial impacts——

Senator CHAFEE. Now we do have a time problem, so could you summarize?

Mr. MANTON. I will collapse it as much as possible. Most importantly is I have three recommendations at the end.

Senator CHAFEE. That is what we always like to hear—recommendations.

Mr. MANTON. At some point you can stop me and I can summarize those three.

Senator CHAFEE. All right, go ahead.

Mr. MANTON. The broad range of financial impacts on both the private and public sector of life expectancy changes places a high premium on forecasting such changes as accurately as possible. Unfortunately, over the last 35 years such forecasts have often underestimated actual mortality declines and underestimated the size of the over-65 population.

A number of factors contributed to these systematic underestimates. First, population scientists tend to view mortality as a realtively stable process. Second, during the period 1954 to 1968 mortality conditions in the United States appeared relatively static. This evidence reinforced the theoretical perspective that human life expectancy had reached levels where biological limits to lifespan would permit little opportunity for improvement.

Furthermore, many of the techniques used to forecast mortality involve simple extrapolations from observed patterns. Forecasts continued to produce underestimates in mortality declines, even after significant declines were observed after 1967.

More recently, forecasts have been prepared by the Office of the Actuary which employ more liberal assumptions about future patterns of mortality declines. Most importantly, the forecasts in the SSA reports are based on mortality trends determined from data covering the rapid declines from 1968 to 1978.

In addition, cause-specific mortality changes are assumed to continue at ultimate annual percentage rates to the year 2080. Thus it should not be assumed that we are near enough to biological limits to the human lifespan to preclude life expectancy improvement, at least through 2080.

Although the 1981 life expectancy forecasts in Actuarial Report 85 represent a considerable increase from prior forecasts, there exist researchers who argue that these forecasts may be too conservative. For example, Crimmins performed projections to evaluate the implications of an assumption made in the forecast in Report 85.

The assumption was that the mortality declines over the period 1968 to 1978 were historically extreme and would be unlikely to continue. Consequently, the observed cause-specific changes were tapered over the period 1981 to 2005 to a postulated ultimate annual percentage change. Crimmins made forecasts where the mortality changes observed 1968 to 1977 continued unaltered to 2000.

Dorothy Rice, former head of NCHS, achieved similar results using a similar methodology, and these were reported in 1978.

Five observations can be made. One, Crimmins forecasts of life expectancy at birth for the year 2000 are 1.4 years higher than the middle mortality variant of the SSA forecasts for males, and 5.1 years higher for females.

Two, the 1981 SSA forecasts for 2000 are much greater than those prepared in 1977. Three, the low mortality variant of SSA forecasts for males and females include Crimmins' forecasts for males, but not females.

Four——

Senator CHAFEE. Do not go too fast here. I read that Crimmins report. I just saw the newspaper account of it. What you are saying is that she based it on the 1977——

Mr. MANTON. 1968 to 1977.

Senator CHAFEE. Whereas in point two here, the Social Security had updated their 1977 report in 1981, is that correct?

Mr. MANTON. Yes. The actuaries have indicated that the mortality assumptions were updated between 1977 and 1981 four times From the Actuarial Report 85 in 1981, the postulated ultimate changes were modified again in Actuarial Report 87, which was published in 1982——

Senator CHAFEE. So I guess what you are saying is that the great discrepancies that Ms. Crimmins noted were not so great given that she neglected to take into account the latest Social Security report?

Mr. MANTON. The later Social Security reports are much closer to her estimates, and their range includes her projected values for males, but did not include—Crimmins' projected life expectancy values for females.

Senator CHAFEE. Is it not very normal to always do both?

Mr. MANTON. To analyze males and females?

Senator CHAFEE. Males and females.

Mr. MANTON. Yes. There are such great differences between male and female life expectancy.

Senator CHAFEE. I know it, but you say that one report did not include Crimmins' forecasts for males. She had a forecast for females.

Mr. MANTON. She forecast values for both males and females. Here numerical estimate was within the range of the alternative 1-alternative 3 values for the social security estimates of male life expectancy; social security used a middle mortality variant alternative 2 and then divided the annual improvement in mortality rates in half for the low values and doubled them, for the high values and this produced a range of estimates.

Crimmin's estimate for males fell within that upper bound of life expectancy change. But for females, Crimmin's estimate fell outside the upper bound, so the uncertainty that the actuaries anticipated would encapsulate what Crimmin's projected for males, but not for females. Consequently, her estimates for females, based on current trends, were higher than the SSA upper range.

Senator CHAFEE. OK. Go ahead.

Mr. MANTON. Because mortality reductions are limited to the postulated ultimate annual percentage changes after 2005 in Report 85, increase over the 20-year period, 1980–2000 is larger than the total life expectancy over the 50-year period 2000–2050. Thus, both the Rice and Crimmins forecasts suggest that the postulated ultimate annual percentage changes in mortality rates are a critical feature of the forecast in Report 85.

To assess the reasonableness of the forecast, one should evaluate the data and analyses by which those values were estimated. Since the process by which the ultimate annual percentage changes were postulated is not well described in the reports, we cannot directly evaluate them. We can ask, however, whether life expectancy levels forecast by Crimmins and Rice are plausible.

Since forecasting life expectancy is difficult and uncertain, fiscal planning should explicitly cover the full range of scientifically defensible alternative estimates. In this assessment we argue that it is not appropriate to evaluate the reasonableness of a set of life expectancy forecasts from the data on which they were based.

This would be a tautology. Assessment of the reasonableness of a set of forecasts must be based on external evidence, in this case biomedical data and theory on human life expectancy and on the impact of medical innovations.

First, Crimmins and Rice's life expectancy forecasts are not inconsistent with rough estimates in changes in life expectancy which biologists suggest could be achieved by eliminating major chronic diseases. Unfortunately, those estimates are based on mortality and are not independent of the data on which extrapolations are generated.

The second type of evidence is available from cross-national studies. For example, we know that certain countries have already achieved male life expectancy levels at birth near the values projected by Crimmins and Rice. In 1981 male life expectancy in

Japan was 73.8. This is one half year less than Crimmins and Rice's projections for the United States in the year 2000.

Is it unreasonable, then, for us to anticipate that we may achieve the same values for life expectancy 19 years after the Japanese? The projected male life expectancy for 2000 in Japan is 77.4, a value which they now anticipate may be too low. The comparable value observed in 1981 for Japanese females is 79.1.

Another important factor is that life expectancy for the current birth cohort is often higher than calculated from the cross-sectional mortality data for the same date. To the extent that we view life expectancy as a biological property of individuals and not a summary index of current mortality rates, the period calculations might also be viewed as biologically artificial. Thus, it may be easier to construct a biomedically motivated model from cohort data.

Additionally, there are often pronounced cohort differences in cause-specific mortality trends. The prime implication of cohort differences is that declines in mortality are likely to be temporarily more persistent than using period data. Thus, we would be more likely to project that mortality rate declines could persist based on cohort extrapolations.

The available quantitative arguments are clearly not definitive but suggest the importance of carefully evaluating the prospects of higher life expectancy changes. Such concern can be argued even more forcefully when we speculate about the effects of technological change and social movements in future life expectancy.

One important factor is that we may be entering a period of major medical advances in the treatment and management of chronic disease. This may be traced to increased funding after World War II of biomedical research in the mechanisms of chronic disease. Systematic research programs on basic aging processes is an even more recent phenomena.

Strehler has speculated that significant interventions in the basic rate of aging might occur in the next 35 years. It seems reasonable to anticipate innovations in the next 100 years.

Noting the time, I think I will jump to some recommendations. At this point we would like to make three suggestions about the process of making life expectancy forecasts.

One, use technical advisory groups. It is not reasonable to expect the Office of the Actuary to evaluate the breadth of scientific evidence we have identified as relevant to making such forecasts. Thus, to aid and facilitate their efforts, we would suggest the creation of two advisory groups.

The first would evaluate epidemiological and biomedical evidence and provide recommendations on how mortality patterns are likely to change and the impact of possible technical innovations. This group would probably best be formed by NIH and NCHS, especially as to how forecasting and technology should be modified to reflect substantive changes and true uncertainty of forecasts.

A second advisory group could recommend how forecasting technology could be modified to reflect substantive changes. This might be formed by the Committee on National Statistics of the National Research Council.

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These two advisory groups might serve to increase confidence in that the full range of scientific evidence is being exploited in forecasts and that some hope was offered for anticipating changes.

The other two recommendations simply are that there ought to be standardization or some process for evaluating the actuarial forecasts used by the different Federal programs. The third recommendation reflects upon the numerous programs dealing with the health and social welfare of the elderly where the quality of life changes that are associated with our projected life expectancy changes may be very important parameters in program planning and management.

As a consequence it seems important to forecast how disability and morbidity change in association with the changes in life expectancy. Thank you.

[The prepared statement of Kenneth G. Manton and answers to questions from Senator Chafee follows:]

TESTIMONY ON TRENDS IN PROJECTED LIFE EXPECTANCY IN THE UNITED STATES

Before

U.S. Senate Committee on Finance, Subcommittee on Savings, Pensions, and Investment Policy

by

Kenneth G. Manton
Associate Research Professor of Demographic Studies
Associate Medical Research Professor of
Community and Family Medicine
and
Senior Fellow, Duke University Center for
Aging and Human Development

Forecasts of future changes in life expectancy, especially changes after age 65, are important for estimating the future liability of many federal insurance and pension programs. For example, in one analysis of Social Security Old Age Insurance indebtedness, it was estimated that a one-year extension of the retirement period could increase indebtedness by $250 billion (Boskin et al., 1980). Social Security is just one of many government programs affected. Changes in life expectancy will also be of great importance for private insurance and pension programs as well as for a broad range of governmental programs providing social and medical services (Torrey and Norwood, 1983).

The financial impact of life expectancy changes places a high premium on a.) producing the most accurate forecasts possible, and b.) in the face of the technical complexity and uncertainty in making such forecasts, appropriately developing fiscal strategies to deal with the uncertainty of such forecasts. Unfortunately, as noted by many investigators, over the last 35 years such forecasts have generally underestimated actual mortality declines and underestimated the size of the over 65 population (e.g., Myers, 1981; Siegel, 1978). Furthermore, as noted by both Myers (1981) and Siegel (1978) though the Census Bureau has tended to revise their projections of the over 65 population upward with time, revised estimates have consistently tended to be low. This can be amply demonstrated by the following table of selected official population projections.

Table 1: Selected Official Projections of the United States Population 65 Years of Age and Over, 1950 to 1980, and Reported Population Figures, 1950 to 1980 (figures in thousands)

Date of Projection	Year for Projection						
	1950	1955	1960	1965	1970	1975	1980
Reported	12,397	14,527	16,659	18,156	20,156	22,405	25,544
7/1977							24,927
10/1975							24,523
12/1972						22,170	24,051
11/1971						21,859	23,703
8/1970						21,503	23,492
2/1967					19,585	21,160	23,063
7/1964					19,571	21,171	23,087
7/1962				18,243	20,035	22,040	24,458
11/1958			15,779	17,638	19,549	21,872	24,526
10/1955			15,800	17,371	18,879	20,655	
8/1953			15,701	17,336	18,885	20,689	
†7/1950L		13,310	15,068				
M		13,491	15,491				
H		13,745	16,127				
†6/1947LM	11,306	12,928	14,675	16,310	18,065	19,935	
HM	11,197	12,592	13,993	15,181	16,404	17,690	

†Different Assumptions.

SOURCES: Selected issues of U.S. Bureau of the Census, Current Population Reports, P-25 Series, *Population Estimates and Projections*. (Adapted from Myers, 1981)

Of particular note is the comparison of the size of the population actually enumerated in the census years 1950, 1960, 1970, and 1980 and the projections of that population at various dates. For example, even estimates of the elderly population made by the Census Bureau released in 1977 for the year 1980 were still 617,000 too low--over a three-year year period. It is also important to note that percentage errors in the projections of the size of the component of the elderly population over age 85 seem to be even larger than the age 65-84 group (Myers, 1981). Since the age 85+ group has generally high health and social service requirements, such systematic error will have a much greater per capita effect. Thus, careful attention must be paid to projections of specific components of the elderly population which will have a disproportionate impact on different types of federal and private programs.

A number of factors contributed to these systematic underestimates. First, population scientists tend to view mortality as a relatively stable population process. Hence, compared to other demographic factors (e.g., fertility), mortality receives relatively little attention from researchers. Second, during the period 1954 to 1968 mortality conditions in the United States were relatively static with male mortality slightly increasing over this interval (S.S.A., 1981, report no. 85). Third, the absolute size of changes in life expectancy at older ages tended to be modest when compared with those at birth--even though the proportional changes were sizeable.

This stasis had three effects. One, it re-enforced the perspective that mortality was static. Two, it re-enforced the theoretical perspective that human life expectancy had reached levels

where biological limits to life span would permit little opportunity for improvement (N.C.H.S., 1964). Three, since many of the techniques used to forecast mortality involved extrapolation from observed patterns, forecasts continued to produce underestimates of mortality declines for a number of years after significant declines began in 1968.

More recently, forecasts have been prepared by the Office of the Actuary of the Social Security Administration (S.S.A.) which employ more liberal assumptions about the future pattern of mortality declines. Most importantly, the forecasts in the S.S.A. reports are based on mortality trends determined from data covering the rapid mortality declines from 1968 to 1978. In addition, cause specific mortality changes are assumed to continue at "ultimate annual percentage" rates to 2080. Thus, it is not assumed that we are near enough to biological limits to the human life span to preclude life expectancy improvement--at least through 2080. A series of analytic studies are presented in Actuarial Report No. 87 (S.S.A., 1982) which suggest the human life span may have increased 8.5 years for U.S. females over the period 1900-1980 (from 105.4 to 113.9)*. Although any estimate of a life span increase is uncertain, it is argued in the report that there is little empirical evidence from human populations to support the notion that we are currently experiencing constraints on life expectancy at later ages.

Although the 1981 life expectancy forecasts in Actuarial Report No. 85 represent a considerable increase from prior forecasts,

*The actual measure studied was "life endurancy," or the age to which 1 in 100,000 people would be assumed to survive.

there exist researchers who argue that those forecasts may yet be too conservative. For example, Crimmins (1983a,b) performed projections to evaluate the implications of an assumption made in the forecasts in Actuarial Report No. 85. The assumption was that the mortality declines over the period 1968-1978 were historically extreme and would be unlikely to continue. Consequently, the observed cause specific changes were tapered over the period 1981-2005 to a "postulated" ultimate annual percentage change. Interestingly, the ultimate annual percentage changes "postulated" for 2005 in Report No. 85 were shortly revised to more optimistic values in Report No. 87. Crimmins made forecasts where the mortality changes observed 1968 to 1977 continued unaltered to 2000.

Five observations can be made about the Crimmins and S.S.A. forecasts.

1. Crimmins' forecasts of life expectancy at birth for the year 2000 are 1.4 years higher than the middle mortality variant of the S.S.A. forecasts for males (74.3 versus 72.9) and 5.1 years higher for females (86.2 versus 81.1). The differences between the projections at this point will be smaller than for years beyond 2000 since the tapering of the rates in the S.S.A. projections to the year 2005 were not complete by 2000.
2. The 1981 S.S.A. forecasts of life expectancy at birth for 2000 are much greater than those prepared in 1977. For males and females respectively, the 1981 forecasts are 72.9 and 81.1 (medium variant), whereas just four years previously in 1977 they were projected to be only 69.6

and 77.4--forecasts which were surpassed in 1980 when provisional life expectancies of 70.0 and 77.7 were calculated (N.C.H.S., 1982).

3. The low mortality (optimistic) variant of S.S.A. forecasts for males (75.9) and females (84.9) include Crimmins' forecasts for males (74.3) but not females (86.2). A similar pattern is noted for life expectancy at age 65 (i.e., 17.4 and 24.2 versus 16.4 and 25.6).

4. Because mortality reductions are limited to the postulated ultimate annual percentage changes after 2005 in Report No. 85, increases over the 20-year period 1980-2000 are larger than over the 50-year period 2000-2050 (i.e., for males 3.1 years versus 2.1 years; females 3.4 years versus 2.5 years).

5. Dorothy Rice, former director of the National Center for Health Statistics, also made an alternate set of forecasts which she reported in 1978. She notes that:

"One cannot be certain whether the momentum of the past will continue. Will death rates from diseases of the heart continue to decline? Will those for malignant neoplasms continue to increase? Even our foremost biostatisticians, epidemiologists, and other scientists disagree on the answers to these questions. But since we are not certain of the factors associated with trends in these major causes of death, it is quite difficult to find an effective substitute for extrapolating past trends as the basis for projecting the future health status of the United States." (page 5).

The forecasts conducted by Rice (1978), although using a

slightly different period (1966 to 1976) to calculate mortality trends and a different methodology (i.e., extrapolation of total mortality), produced estimates for the year 2003 similar to those projected by Crimmins (i.e., 74.2 versus 74.3 for males and 84.2 versus 86.2 for females).

The conclusion to be reached from both the Rice and Crimmins forecasts is that the postulated ultimate annual percentage changes are a critical feature of the Report No. 85 forecasts, especially for forecasts after the year 2000. Thus, to assess the reasonableness of the forecasts one should evaluate the data and analyses by which those values were estimated. Since the process by which the ultimate annual percentage changes were postulated is not well-described in the reports, we cannot directly evaluate them.

Instead, we must proceed indirectly and determine whether life expectancy levels forecast by Crimmins and Rice are plausible. In one way this may be even more important than evaluating the middle variant of the S.S.A. forecasts for this will tell us the likelihood of experiencing even more extreme life expectancy increases. By "plausible" we do not necessarily mean "most likely". This is because we are assuming that a prudent approach to financing is to maintain adequate resources to cover reasonable variations in outcome. Since our perspective is that forecasting life expectancy is a technically difficult and uncertain task, we would argue that fiscal planning should explicitly consider the full range of scientifically defensible alternative estimates. Assessing the full range of scientifically plausible projected life expectancy values and selecting a reasonable upper bound figure is a procedure

that must be justified by identifying the different types of risks in accepting any one set of forecasts for the purposes of planning. The operational principle in producing life expectancy forecasts, at least up to the forecasts presented in Actuarial Report No. 85, seems to be one of "scientific" conservatism. That is, based upon existing data and a wide range of scientific opinion the forecasts were constructed to project what were then perceived as scientifically conservative values of future life expectancy. There are a number of legitimate questions about whether these estimates were the best that could be achieved. Putting technical issues aside, it seems that the fiscally conservative approach would have been to plan on plausible high values. The implications of the errors of such an approach seem to be simply to generate reserve funding.

The assumption that alternative projections could be generated by assuming that Alternative I and III annual improvements averaged "half and twice the Alternative II improvements" (p.7) probably does not adequately represent the true degree of uncertainty in those forecasts. Such a practice will tend to give a very narrow confidence interval when anticipated changes in mortality are small, and a large interval when anticipated changes are large. For example, if one were to assume no change in the mortality rates, all three alternatives would be identical (i.e., a range of 0.0) using this procedure. That is, the range of projections is a function of the assumptions rather than of the data and, hence, could be viewed as tautological. Furthermore, the high and low mortality alternatives will likely produce overly broad ranges for short-run projections and too narrow ranges for longer-run projections because of the way stochastic error will propagate over time. A more satisfactory procedure would be based on explicit analytic consideration of the empirical variation of mortality conditions in the past. Even such

a time series analysis of the variance of past mortality will not, however, be able to anticipate major technological innovations. For example, it should be recognized that Rice's and Crimmins' projection of future life expectancy changes are, by no means, the most extreme. There are a number of biologists (e.g., Strehler and Walford) who argue that we may experience major changes in life expectancy due to the development of practical life span extension technologies.

In an assessment of the plausibility of the Rice and Crimmins forecasts, we argue that it is not appropriate to evaluate the reasonableness of a set of life expectancy forecasts from the data on which they were based. This would be tautological. Assessment of the reasonableness of a set of forecasts must be based on external evidence--in this case, biomedical data and theory on human life expectancy and on the impact of medical innovations on a wide range of morbidity/mortality processes. Indeed, forecasting by extrapolating past trends in mortality rate changes will be sensitive to the interval over which past trends are measured. Additionally, forecasts based on the extrapolation of past trends will be unlikely to anticipate changes in mortality patterns due to significant improvements in medical technology, advances in life span extension, or major changes in lifestyle.

First, the higher projected life expectancy values estimated for the year 2000 do not seem to be inconsistent with the rough estimates of the changes in life expectancy which Strehler (15 years--1975), Hayflick (20 years--1977), and Fries (upper limit of 85.6 years--1980) suggest could be achieved by the elimination of

mortality from major chronic diseases (i.e., without an alteration of biological life span). Unfortunately, the estimates produced by Strehler and Hayflick from life table analyses and the estimates produced by Fries' extrapolation procedure are all based on U.S. mortality data and thus are not independent of the data used in determining trends for extrapolation. Furthermore, they are based on methodologies (i.e., cause elimination strategies for Strehler and Hayflick; extrapolation of rates of change in age specific life expectancy for Fries) that are subject to certain technical criticisms (Manton, 1982).

A second type of evidence is available from cross-national studies of mortality patterns. For example, we know that certain countries have already achieved male life expectancy levels at birth near the values projected for 2000 under the assumptions made by Rice and Crimmins that the recent rate of life expectancy improvements could continue. In 1981 male life expectancy of 73.8 years has been observed in Japan (Koizumi, 1982). This is about one-half year less than that projected by Rice and Crimmins for the United States in 2000 assuming a continuation of the current rate of mortality reductions. It is also equal to the "best county composite" estimate of life expectancy based on observed mortality patterns in 1974 (Siegel, 1978). Is it unreasonable, then, for us to anticipate that we may achieve the same values for male life expectancy 19 years after the Japanese? The comparable value observed in 1981 for Japanese females is 79.1. This is also close to the best country composite estimate of life expectancies (79.4) based on the mortality experience of 1974 (Siegel, 1978). We might also note

that efforts to project limits on life expectancy change based on observed patterns are themselves endeavors which led to revisions as projections of ultimate life expectancy values were approached and then exceeded (e.g., Bourgeois-Pichat, 1978). Thus, extrapolation of mortality conditions based on international experience may also tend to understate what is biologically feasible in mortality reductions.

Another important factor in evaluating the likelihood of continuing major increases in life expectancy is that the life expectancy for the current birth cohort is often higher than calculated from the cross-sectional (or period) mortality data for the same date (Jacobson, 1964; Dublin and Spiegelman, 1941; Myers, 1981). This is because the period mortality rates for later ages reflect the generally higher mortality rates of older cohorts.

Furthermore, to the extent that we view life expectancy as a biological property of individuals and not a summary index of current mortality rates, the period calculations might be viewed as biologically "artificial." Thus, it may be easier to construct a biomedically-motivated model from cohort or partial cohort data (Manton et al., 1981). Additionally, there are often pronounced cohort differences in cause specific mortality patterns (Patrick et al., 1982; Manton and Stallard, 1982). One important implication of a major component of cause specific mortality declines being a product of cohort differences is that such declines are likely to be temporally more persistent. Thus we would be more likely to project that mortality rate declines would persist based on a cohort extrapolation model. The primary restrictions on cohort models are more stringent data requirements.

The available quantitative arguments are clearly not definitive, but suggest the importance of carefully evaluating the prospects for life expectancy changes higher than those currently projected. Perhaps the reasonableness of concern over such prospects can be argued even more forcefully when we speculate about the effects of technological change and social movements on future life expectancy.

One important factor is that we may be entering a period of major medical advances in the treatment and management of chronic disease. This may be traced to the increased funding after W.W. II of biomedical research into the mechanisms of chronic disease. Given that systematic research programs on basic aging processes are an even more recent phenomenon (N.I.A. initiated in 1976, see Strehler, 1977), it might be reasonable to expect significant interventions in the basic rate of aging in the next 35 years (Strehler, 1975). Certainly it is reasonable to anticipate innovations in the next 100 years.

Such speculations raise questions about how life expectancy forecasting techniques should possibly be modified--especially to reflect mortality changes at later ages. In particular, there are a number of medical and epidemiological questions that might be raised in extrapolating mortality rates for major causes of death. For example, the category of malignant neoplasms is a quite heterogeneous collection of diseases with much of the recent modest increases attributable to lung cancer. Thus the cause of death categories used for projection may aggregate over diseases with different trends making it difficult to anticipate future changes. Certain investigators have argued that deaths at later ages are often mis-

takenly assigned to various disease categories and that mortality from aging processes should often be diagnosed as a discrete pathological entity at later ages. Though a highly speculative notion, this would call into question the use of a cause specific strategy for forecasting future mortality rates--especially at later ages. Others have questioned the assignment of deaths to certain disease categories (e.g., it has been argued that Alzheimer's disease might be the fourth leading cause of death). Research has also indicated the importance of multiply-caused death at later ages (Manton and Stallard, 1982). Since N.C.H.S. has released multiple cause mortality data for most years 1968-1979, forecasts could be based on data with considerably more information on morbid and mortal processes. Finally, all of these arguments suggest that we may need to conduct a basic conceptual re-assessment of morbidity and mortality at later ages (Manton, 1982)--a re-assessment that might lead to alternate modes of forecasting.

Another important factor in projecting life expectancy change is that policy commitments will affect whether life expectancy changes that are technically feasible are achieved. Their achievement will depend on the national level of commitment to health service delivery and the improvement of health status among the elderly. Such factors represent a series of imponderables that will be difficult to represent in any series of mortality forecasts. Nonetheless, the sensitivity of the life expectancy forecasts to such changes could be assessed. Precedents for this are found in Japan where several major econometric studies of population aging, including health status and life expectancy change, have been conduct-

ed (Ogawa, 1982; Nihon University, 1982).

Finally, one should be aware of the potential impact of certain social phenomena on life expectancy change. First, there are many groups involved in health promotion through nutrition and exercise. It is notable that one strategy for life span extension that has been proposed, based on scientific evidence from animal models, relies upon modification of nutrition. Many other groups are involved with educational programs to control certain major risk factors. Recently we have seen evidence of their efficacy, e.g., smoking levels have moderated in certain population groups in the United States. More recently, we see the emergence of groups explicitly concerned with longevity and life span extension (e.g., the American Longevity Association). This suggests that if the technology becomes available for life expectancy increases, there is considerable public interest and motivation to employ it.

At this point, we should like to make three recommendations for improving the process of making life expectancy forecasts.

1. Technical Advisory Groups--It is not reasonable to expect the Office of the Actuary to evaluate the breadth of scientific evidence we have identified as relevant to making forecasts. Furthermore, it is undesirable to constantly change forecasting procedures and assumptions. Thus, independent advisory groups could fully evaluate both new methods and substantive insights before making recommendations about possible changes in forecasting. Thus to aid and facilitate their efforts, we suggest the creation of two advisory groups.

The first would evaluate epidemiological and biomedical evidence and provide recommendations on how mortality patterns are likely to change, and assess the impact of possible technical innovations. This advisory group would probably best be formed by the National Institutes of Health and the National Center for Health Statistics.

Second, it is important that advice on forecasting and statistical technology be available--especially as to how forecasting technology should be modified to reflect substantive changes and the true uncertainty of forecasts. The trend extrapolation methodologies typically employed in forecasting life expectancy might be considered primitive by statisticians and mathematicians specializing in time series modeling and forecasting. This would be especially true of the ways in which the uncertainty of future forecasts is assessed. Such a committee might be formed by the Committee on National Statistics of the National Research Council.

The impact of these two advisory groups may be as much to increase our confidence in mortality forecasts as to actually change forecast values. At least we would feel confident that the full range of scientific evidence was being exploited and that some hope was offered for anticipating changes.

2. Standardization--It has been found that there is considerable variation in the actuarial statistics used by various federal insurance and pension programs. For example, the

Federal Reserve uses Group Annuity tables from 1951 when life expectancy at age 65 was 15 percent less than it is today (Torrey and Norwood, 1983). Given the fiscal significance of life expectancy forecasts, it seems critical that standards are established for federal agencies and programs to insure that they are employing the most current and up-to-date forecasts. Questions of such standardization might appropriately fall to executive OMB.

3. The Association of Health Status and Functional Change With Life Expectancy Changes--The fiscal commitment of many federal agencies may be dependent on how functional and health status changes as life expectancy is increased. This is particularly true for the very old population (i.e., ages 85+) whose need for health and social services is likely to be high but for whom forecasts have even greater biases than the total ages 65+ population. Thus, projections of the changes in "quality of life" perhaps should be conducted in parallel to changes in "quantity of life." Conceptual models for integrating forecasts and estimates of life expectancy change with morbidity and disability have been developed and actually employed to assess the health status of the Japanese population. These issues are certainly of great importance in assessing entitlement age issues. Some such efforts are necessary though the Office of the Actuary may not be the appropriate agency to undertake them.

Given the immediacy and magnitude of the implications of mortality changes for Social Security and many other federal, state, and private programs, it seems reasonable that serious attention be paid to the process for making such forecasts and to any possibility for improving the quality and public and scientific credibility of that exercise.

Where does this go.

SENATE TESTIMONY

I. There Are Two Specific Steps That Should Be Undertaken To Improve Our Life Expectancy Projections

A. Increase the Range of Scientific Input to the Forecasting Process

Current procedures for making life expectancy projections do not adequately take into account the range of scientific evidence that must be considered if those projections are to be fully scientifically credible. The additional scientific input that must be taken into account is both substantive and methodological in nature.

1.) Necessary substantive inputs

Forecasting future morbidity and mortality risks is a topic of considerable complexity and one for which there exists a wide range of evidence derived from numerous epidemiological studies. Two particular substantive inputs need to be incorporated into these forecasts. First, medical advances related to prevention, early detection, and therapy must be assessed. Assessing the impact of innovations in clinical science and life span extension is a complex and hazardous task. Nonetheless, one can probably make reasonable guesses about the likely impact of such innovations in the next 20 to 30 years based upon a.) the current level of effort in basic biomedical and clinical studies and b.) the current status (i.e., primary findings) of research in those areas. Second, changes in the distribution of risk factors among generations need to be considered. The increase in education, athletic participation, nutrition, and changes in smoking and drinking behavior and other known risk factors need to be factored into the forecasts of

life expectancy based on current findings.

Thus, a technical advisory board should be formed to aid the forecasting efforts of the Social Security actuaries by collecting information on the status of basic and clinical science as well as risk factor distributions and by helping the actuaries assess the likely implications of these factors for future life expectancy changes. For example, such an advisory group could help assess the likelihood of basic breakthroughs in life span extension technology which a number of well known scientists (e.g., Strehler and Walford among others) believe are possible. Such a scientific advisory board could be formed by the National Institutes of Health (e.g., N.I.A.) and draw upon the current leaders in biomedical research.

ii.) Necessary methodological inputs

The current methodology for making life expectancy forecasts do not take advantage of a wide range of statistical and mathematical techniques that have been developed for modeling time series data and in forecasting. Such technical innovations in forecasting must be evaluated in order to determine how the current forecasting methodology should be improved. We feel that the procedures currently employed in forecasting life expectancy would not, for example, be viewed as adequate for modeling time series and forecasting by the statistical and scientific community. For example, the forecasting technology used in the evaluation of many individual Defense Department applications is considerably more sophisticated than the technology used in forecasting life expectancy changes--even though the fiscal impact of each of those individual defense programs will be far smaller. Of particular emphasis in the

development of new forecasting procedures should be the assessment of ways in which more realistic assessments of the variation in life expectancy forecasts could be produced. Such a committee should draw upon experts in the current "state of the art" in forecasting. Such a committee should properly be formed by a group such as the Committee on National Statistics at the National Research Council. Naturally the efforts of this committee on statistical methods and the scientific advisory committee on biomedical and epidemiological factors should be strongly coordinated.

B. Implement a Formal Review Process for Life Expectancy Projection

Forecasts of life expectancy changes are important for over 51 retirement programs for federal workers, in addition to Social Security and private plans. Currently there appears to be little coordination or standardization of forecasts used for program planning. Thus it seems essential that a review process be implemented to assess life expectancy forecasts to achieve the following goals.

1.) Standardization

It is desirable to insure that federal programs are using credible, up to date life expectancy forecasts. The available evidence suggests that there is a wide variability in the currency of the life expectancy forecasts used by various programs. Clearly then a commission to insure that minimal standards are met is necessary.

2.) Credibility

Forecasts of future life expectancy change must not only be as accurate as possible but also credible. It is likely that a process for reviewing the life expectancy assumptions for various

federal programs could greatly increase their credibility. Specifically, such life expectancy assumptions are one component in determining the future liability of these programs. The failure to have an independent review of these assumptions is analogous to a failure to have an independent audit of the financial status of a corporation. If a total reliance on an internal audit of the assets and liabilities of a corporation is not credible in the corporate world then the failure to independently audit the assumptions determining the future liability of federal pension or insurance programs can be no more credible. A further current practice that adversely affects the credibility of life expectancy forecasts is the continual adaptation of mortality assumptions for long range forecasts. It is difficult to have confidence in forecasts that have been revised so often. An independent review commission could possibly resolve this difficulty.

3.) Assurance that policy goals are met

Currently many policy goals and Congressional actions must be implemented through a series of technical decisions. It is possible that those technical decisions can influence or even determine the outcome of policy and Congressional actions. It is necessary to have an independent assessment of whether the technical decisions will implement the intent of the policy or Congressional action. For example, a fiscally conservative approach to life expectancy forecasts is to attempt to insure that the bias in forecasts is toward over estimation. This will imply a tendency to have adequate funding even in the face of short-run variations. With such policy it would not be necessary to "adapt" and "fine tune" life expectancy forecasts so often.

Operationally, executive OMB has the responsibility for standardizing a broad range of government technical applications. For example, federal data collection efforts (down to the actual design of questionnaries) are currently reviewed by them. It would thus seem appropriate that they perform this independent review.

II. The Effects Of An Aging Population

I do not believe that it is utopian to expect people to begin new careers after age 62 or 65 for a number of reasons. First, increases in life expectancy at later ages is a relatively recent phenomena. Current retirement plans made by individuals may not take this situation into account. Thus average age at retirement and labor force participation of those over 65 have been declining even as life expectancy has increased. Second, there are many international examples where persons remain actively involved in the labor force, though possibly in a modified role, at later ages (e.g., Japan). Third, there are currently many economic and institutional pressures to retire. If these barriers were removed, persons might choose the greater economic benefits of remaining in the workforce. Finally, recent scientific evidence from a number of groups suggests that the functional status of older persons can be improved even at fairly advanced ages. If the potential for regaining such functional capacity is great then certain types of retraining programs could be instituted to retain older workers in the labor force.

These factors must be considered in the face of certain caveats. First, the desire to remain in the labor force will strongly be related to the nature of the job held by a person. For example, construction workers might be very difficult to retain in

the labor force. With the shift of the economy to a high technology basis, this may be less of a hinirence to continued labor force participation than in the past. Second, one must carefully consider the "social contract" that is implied by the current social insurance system. That is, for workers currently paying into the system there has been created an expectation of certain retirement benefits. Thus, if changes are to be implemented they must be implemented far enough in advance that expectations generated by this social contract are fulfilled. This is one reason why constantly adapting life expectancy forecasts to current conditions will not be satisfactory.

III. Problem of Mortality Forecasting For Retirement Plans

The current liability of any retirement or pension program will be determined by the number of persons currently in the system and the average number of years they can expect to live. Thus, life expectancy must be an important determinant of the current indebtedness of such programs. Clearly a wide range of factors must be considered in the assessment of the fiscal soundness of any program. For example, current fertility rates will determine the number of workers who will enter the labor force 20 to 25 years later to support the retired population. Economic conditions and unemployment rates may also affect the availability of funds to meed current liability. Current fertility rates will affect the number of retirees 65 or more years in the future. Though all of these factors deserve consideration, it is still evident that life expectancy is an important determinant of program liability and it is probably the factor that has received the least attention by researchers and policy planners. It is also a factor over which there is considerable uncertainty about the implications

of certain basic scientific breakthroughs and technological innovations (i.e., life span extension technology).

IV. Life Expectancy Trends In Foreign Countries

There are several lessons to be derived from a study of life expectancy trends in foreign countries. First, there are several countries that have achieved life expectancies greater than in the U.S. For example, life expectancy at birth in Japan in 1981 was 73.8 years for males and 79.1 years for females. An even higher life expectancy for females is claimed in Iceland. The 73.8 years achieved for Japanese males in 1981 is particularly notable, given the value of 74.2 and 74.3 years for U.S. males in 2000 extrapolated by Crimmins and by Rice. It strongly implies, for males at least, that there are no biological limits to prevent achievement of much greater life expectancy levels in the U.S.--especially for males. It should also be noted that increases in life expectancy have not been universal in developed countries. For example, increases in Eastern European countries have been smaller than in the West, with the Soviet Union apparently experiencing decreases in life expectancy. Male life expectancy in the U.S.S.R. reached a peak of 66 years in the mid-60's and dropped to only 64 years in 1971-72. Soviet mortality data have not been reported since 1972 and there have been few recent studies of those trends. Indeed it seems to be explicit Soviet policy not to report current life expectancy levels and mortality conditions. The situation for Soviet females is somewhat different, with female life expectancy being similar to that for Eastern European females ($\sim$74 years). These declines for males suggest that life expectancy increases are not inevitable and that a failure to actively pursue improved

health can lead to actual declines in life expectancy.

It is also instructive to note that officials in Japan are very concerned about their planning which did not take into account the rapidity and magnitude of the life expectancy changes they experienced. Their calculations show that economic growth and public expenditures are very sensitive to assumptions about life expectancy change. Furthermore, causality in the reverse direction (i.e., of the effects of economic growth and public expenditure on life expectancy) must be recognized. This is why the Japanese have explicitly included health status and life expectancy in econometric models of their pension and social security systems.

It should also be noted that many developed countries have achieved their current life expectancy levels by different pathways i.e., by reducing the mortality risks of different diseases. For example, stroke was the number one cause of death in Japan in 1980 with rates (139.7 per 100,000) much higher than in the U.S. If the Japanese could reduce the stroke mortality rates to U.S. levels, they could considerably increase their already high life expectancy levels. Likewise, if the U.S. could reduce the heart disease mortality rate to Japanese levels we could also achieve major increases in life expectancy. This suggests a considerable potential for increases in life expectancy due to the elimination of chronic disease risks.

Senator CHAFEE. Your definition of quality of life depends how fit the person is and whether they can participate and function as an active human being, as opposed to somebody who is ill in a nursing home?

Mr. MANTON. Right. Quality of life should be considered explicity in terms of both morbidity and disability which would reflect the ability to maintain normal daily functions.

Senator CHAFEE. All right. We will have some questions for you, but let us take Dr. Keyfitz.

STATEMENT OF NATHAN KEYFITZ, DEPARTMENT OF SOCIOLOGY, OHIO STATE UNIVERSITY

Mr. KEYFITZ. Thank you, sir. I was only informed of this as recently as Tuesday, and so I did not have a chance to prepare a written statement.

Senator CHAFEE. That is all right.

Mr. KEYFITZ. But I did have a chance to get on my microcomputer and make some calculations, and I have a few copies here.

Senator CHAFEE. Good. I want to say to all the witnesses that we appreciate your coming on and helping us out. I know under the austerity rules of the Congress we do not pay witness transportation, which you are painfully aware of. So we are grateful to each of you and the other witnesses today for taking the trouble.

All right, Dr. Keyfitz, go to it.

Mr. KEYFITZ. What I did was to make an independent forecast of the population of the United States and the population of working age, the population 65 years of age and over, not because I know the future better than anybody else, but because I have studied the past and I am able to make the assumption that the variation in the future is going to be similar to the variation in the past.

And that is what these are based on. The assumption gives a range on which you can bet 20-to-1 odds the future population will lie.

Senator CHAFEE. Do I understand what you are saying? You are basing your statistics on what has happened in the past?

Mr. KEYFITZ. That is right, including the trend of past improvement, and especially including the variation, the unanticipated variation in the past.

Senator CHAFEE. All right.

Mr. KEYFITZ. I will not ask you to look at all the numbers here but in the lower righthand is a figure 519.36 on the first page, which is the ratio of people of retired age, people of 65 and over, to those 20 to 65, in what Mr. Bayo had called the worst case.

Senator CHAFEE. If people live longer?

Mr. KEYFITZ. Yes. So if you look along that line you will see how in this case we start at about 200 per 1,000—that is the present condition—and then we do not get much worse until about the year 2010.

Senator CHAFEE. Perhaps if the other witnesses had this, then they could follow along, because we would be interested in their comments. Now, Doctor, you have to speak right into that mike.

Senator CHAFEE. We are on the bottom line of the first page, is that right, not quite the bottom line?

Mr. KEYFITZ. That is PR for premium, that is to say, the ratio of the 65 and over to those 20 to 65.

Senator CHAFEE. For instance, the last figure is 519.

Mr. KEYFITZ. That is right.

Senator CHAFEE. In the year 2035, what does that figure 519 mean?

Mr. KEYFITZ. That tells you that for each 1,000 people of working age, there will be 519 drawing.

Senator CHAFEE. Over 65?

Mr. KEYFITZ. That is right. This is the worst case and the next page gives you the middle case.

Senator CHAFEE. And if you go back on that in 1980, let's take 1985, it is just about 200 people over 65.

Mr. KEYFITZ. Per 1,000 20 to 65.

Senator CHAFEE. Per thousand people over 20.

Mr. KEYFITZ. Per thousand, 20 to 65.

Senator CHAFEE. Per thousand contributors. I see. So, in other words, it is 5 to 1.

Mr. KEYFITZ. Yes, that is right. One of the things this tells you is that present difficulties in the social security position really are not due to demographic causes—not yet. Those demographic causes will really start to operate around the year 2010, so we will have all of our present troubles, plus the demographic ones starting in the year 2010—

Senator CHAFEE. Because in 2010 this thing really starts shooting up, from 234 to 273, to 326, to 399, to 474, to 519. These figures represent the number of people drawing to the per thousand contributors.

[Prepared statement of Nathan Keyfitz follows:]

Statement of Nathan Keyfitz
Andelot Professor of Sociology and Demography
Harvard University
Robert Lazarus Professor of Social Demography
The Ohio State University
To the Senate Committee on Finance
Subcommittee on Savings, Pensions, and Investment Policy
July 15, 1983

Summary

The short version of my statement is

1. The present difficulties of social security and those in prospect up to the year 2015 are not primarily due to demographic but to economic causes.
2. If past tendencies continue the extension of life will indeed impose a burden on the program, but low births subsequent to the baby boom will have greater effect.
3. An unprecedented extension of the life span, of which there is so far no sign, would have the most drastic consequences for social security.
4. Experience shows that forecasts are subject to substantial error, and this has not so far been adequately taken into account in planning taxes and benefits.

My contribution consists in measuring these effects.

Pay-as-you-go Rests on Increase of Population and Income

On the system of social security that we have in the United States and Western Europe, increase of population and of income provide a quasi-interest to participants. If over a long period population increases at 2 percent and income at 5 percent, then it is a mathematical fact that participants will obtain an effective 7 percent per annum on their contributions. The

statement is true whether expressed in money terms or in fixed dollars. Something like that condition has held in the past; it cannot be counted on for the future. Slowing of population and economic growth shows through as rising costs in relation to benefits. The public is disappointed that present generations cannot expect the generous return that our parents had.

For this purpose change of population and change of income are equivalent. The dollars earned by those 20-65 provide the incomes to those 65 and over. If the dollars subject to social security tax keep increasing, that is just as good as the population increasing; a given fraction of current income paid in tax and divided among the beneficiaries will provide them with a generous return on what they contributed in their time.

TABLE 1 shows the cost to current wage-earners of a fixed benefit of $1000 to those past 65. Under each percent rate is the payment that must be made per $1000 benefit if the number of wage-earners has been rising at the percent given. The percent increase of the population or of the economy will continue to provide quasi-interest in the future, but at a lower rate than it has in the past.

Social security was intended to help the working man, and for several decades it did, but we have now moved into a more nearly stationary condition in which the working man will obtain a smaller return on his investment through social security than he would if allowed to invest the same funds in bonds or equities. No alteration of demographic conditions is likely to change this; we are not going back to 5-child families.

TABLE 1. RATIO OF POPULATION AGED 65+ TO THAT 20-64 WITH VARIOUS LIFE EXPECTANCIES AND RATES OF POPULATION INCREASE (PER THOUSAND PERSONS)

EXPECTATION OF LIFE	RATE OF INCREASE OF POPULATION				
	-1%	0%	1%	2%	3%
73	418	300	213	151	106
76	471	337	239	168	118
79	532	379	269	189	132
82	603	429	303	212	148
86	687	487	343	240	166

With pay-as-you-go the burden depends on expansion, and the above table shows in what degree. It can be interpreted as the effect of the expansion of the population or the economy or both. If our population had been increasing at 3 percent per year we would have a ratio of drawers to contributors one third as large as if we were stationary: 106 per thousand against 300 per thousand. The burden goes up from 300 to 487 under stationarity as life expectancy rises to 86 years, but even a moderate rate of increase could offset this. If we compare 0 percent increase at the present expectancy of 73 years to 2 percent increase with an expectancy of 86 years, the burden falls from 300 to 240. Expansion of the economy has a similar effect if the burden of contribution is reckoned as a fraction of wages.

The prospects starting about 2020 are dismal. The estimate in the last three lines of TABLE 2, assuming the continuance of present fertility and a fall in mortality only about half as fast as during the 1970s, gives the number of persons aged 20 to 64 and the number 65 and over. For what is left of the 20th century the two rise at about the same rate, but in the 21st century pensionable persons rapidly outstrip those of working age. The demographic component of the tax per $1000 of pension more than doubles, rising from less than $200 to over $400. This rise can be disregarded for the next 30 years, but after that it will hit hard. To fail to provide for it in advance causes inequity between the generations.

Our medium estimate of TABLE 2 was worked out independently of the United Nations and of the U.S. Bureau of the Census, but it comes close to their results. Thus we have (in thousands):

Year	Present paper	UN 1980 assessment	USBC 1983
1980	226,506	223,233	226,506
2000	268,264	263,829	267,990
2020	299,075	298,986	296,339
2040	315,468		307,952

differences far less than the error of any of the estimates.

The projection (TABLE 3) that shows the prospects of social security in the worst light is the one that has low fertility, low mortality, and low immigration. (Note that this does not give the lowest possible population, which would be obtained with high mortality.) The wide range of uncertainty in the numbers of

TABLE 2. POPULATION PROJECTION FOR THE UNITED STATES FROM 1980, WITH PRESENT FERTILITY, MORTALITY DECLINING AT ABOUT ONE HALF THE RATE OF THE 1970S, AND NET IMMIGRATION OF 700,000 PER YEAR; thousands of persons.

	1980	2000	2020	2040	2060	2080	2100
0-	16,344	16,884	17,118	16,782	16,560	16,466	16,380
5-	16,697	17,880	17,531	17,037	16,909	16,824	16,717
10-	18,241	18,803	17,614	17,316	17,287	17,155	17,030
15-	21,162	18,859	17,645	17,782	17,695	17,493	17,376
20-	21,313	17,560	18,138	18,397	18,082	17,875	17,790
25-	19,518	18,050	19,275	18,966	18,500	18,389	18,318
30-	17,558	19,575	20,211	19,085	18,822	18,816	18,703
35-	13,963	22,279	20,128	18,993	19,168	19,111	18,932
40-	11,668	22,103	18,564	19,202	19,506	19,231	19,051
45-	11,088	19,799	18,535	19,828	19,593	19,182	19,109
50-	11,709	17,312	19,466	20,230	19,241	19,056	19,104
55-	11,614	13,312	21,380	19,593	18,664	18,942	18,971
60-	10,086	10,570	20,356	17,467	18,287	18,742	18,610
65-	8,000	9,324	17,267	16,644	18,137	18,176	17,988
70-	7,578	8,878	13,996	16,403	17,540	17,041	17,148
75-	4,000	7,546	9,591	16,367	15,681	15,423	16,031
80-	3,000	5,200	6,388	13,497	12,393	13,611	14,467
85-	2,967	4,328	5,872	11,879	12,191	13,885	14,391
TOTAL	226506	268264	299075	315468	314255	315417	316115
LIFE EXPECTANCY	73.31	77.03	79.40	81.04	82.24	83.16	83.88
RECTANGULAR H	0.163	0.132	0.110	0.094	0.082	0.073	0.066
BIRTHS	0	3413	3452	3379	3331	3309	3290
NRR	0.88	0.89	0.89	0.89	0.90	0.90	0.90
RATE OF INCREASE	0.00	0.85	0.70	0.55	0.41	0.33	0.28
PERSONS 20-64	128517	160563	176053	171762	169863	169343	168588
PERSONS 65+	25545	35276	53114	74790	75941	78137	80025
RATIO 65+/20-64	198.77	219.70	301.69	435.43	447.07	461.41	474.68

The bottom line is the ratio of persons 65 and over to those 20-64, what may be called the burden of social security. Its increase is small until about 2020. Note that the peak of the age distribution is at 15-24 years, and it reaches 55-64 years by 2040. Our assumption of 700,000 net immigrants helps to soften the effect of the baby boom, but even so the burden of social security remains above 400 for the rest of the 21st century. That means more than twice as much tax as is now required.

both pension age and working age in the year 2100 is in accord with the record of past failures in forecasting. Even for 2040 we can bet not much better than 2:1 odds that the numbers aged 20-64 will be between 136 and 210 million.

TABLES 6A and 6B, from which TABLE 3 is extracted, are calculated from the history of variation of births, deaths, and migration. From that variation my program calculates the one-sixth point and the five-sixths point, so that one could bet 2:1 odds that for a future time the births will be between these two points. With the same treatment of deaths and migration the range presented offers somewhat better than 2:1 odds of straddling the population.

Mortality--Is There a Limit to Improvements?

The chief question regarding mortality is whether it will continue along present lines, with the probability of dying at ages up to the 80s steadily decreasing, but without any great change in the highest ages at which people die. The factor that translates decline in age-specific rates into an increase in expectation of life is called H; it now stands at 0.16 for the United States, which means that we are at the point where a 1 percent improvement in the probability of dying at individual ages is translated into an extension of the expectation of life of only 0.16 percent, or 73 x 0.0016 = 0.12 years. For example, a fall of nearly one quarter in the average age-specific death rates between 1970 and 1980 showed up as an increase of less than 3 years in life expectancy. The index H tends to zero as we move to a rectangular survivorship curve; it is forecast to be

TABLE 3. ESTIMATED PERSONS OF WORKING AND PENSIONABLE AGES

Millions

	LOW ESTIMATE		MEDIUM ESTIMATE		HIGH ESTIMATE	
YEAR	WORKERS	PENSIONERS	WORKERS	PENSIONERS	WORKERS	PENSIONERS
1980	129	26	129	26	129	26
2000	156	37	161	35	165	34
2020	157	54	176	53	195	52
2040	136	74	172	75	210	76
2060	120	67	170	76	226	85
2080	107	61	169	78	245	96
2100	96	55	169	80	263	107

The middle set above is obtained from TABLE 2; the high and the low are derived from the variation about the mean shown in the past for fertility, mortality, and migration (Tables 6A and 6B of the Appendix give more detail). Low fertility was the present birth rate less 11%, ±11% being the range within which two thirds of past decades fell in respect of fertility. Similarly for mortality and migration; in each case we tried to include a range such that the odds of the future falling within it would be about 2:1. Low mortality increases the number of persons over age 65, an effect offset by migration, even in the immediate future.

The relationships vary according to the time period. Pensioners are nearly the same on all three estimates for the years up to 2040, after which the high estimates rise steeply as the added births come to pensionable age. The number of workers is affected much sooner by births, so the funding of social security will be easier until the year 2040 with the high estimate: the advantage of high births can more than offset the high deaths.

One conclusion from this is that we ought to consider separately the bounds on the forecast set by the three input components, a point taken up in TABLE 4.

TABLE 4. RATIO OF PERSONS AGED 65+ TO THOSE 20-64 ON LOW FERTILITY, MORTALITY AND MIGRATION (PER THOUSAND PERSONS)

YEAR	NORMAL AS EXPECTED	LOW FERTILITY	LOW MORTALITY	LOW MIGRATION	ALL LOW
1980	199	199	199	199	199
2000	220	220	230	225	236
2020	302	316	313	315	343
2040	435	492	451	457	541
2060	447	506	460	468	553
2080	461	519	474	482	566
2100	475	529	486	496	576

This condensed version of material contained in the Appendix compares the three components of population growth in their effects on the ratio of beneficiaries to payers.

By "low fertility" we understand such a departure from present fertility as was to be observed one sixth of the time in the past, and similarly for mortality and migration. With low fertility the cost per $1000 of pay-as-you-go pension goes up to $529 by the year 2100, as against $475 with expected fertility; the rise due to low fertility is thus $529 - $475 or $54. The corresponding rise for low mortality would be $486 - $475 or $11, and for migration $496 - $475 or $21. Thus fertility is five times as important as mortality, and migration twice as important. All this is on the supposition that the span of life remains unchanged; the effect of changed span of life is a very different matter.

down to 0.07 by the late 21st century. That shows how little further reduction of death rates will affect expectation of life, always assuming no change in life span.

On this model that everyone uses, because it represents the only type of improvement we have seen in the past, gains in life expectancy will gradually slow until it is about 85 to 90 years, where it will remain, limited by the aging of the individual cells of our bodies. What is the likelihood of a breakthrough that will take us beyond the conquest of present-day diseases into an era of cell preservation?

The reduction of mortality up to now was not a single event, but a sequence of apparently repeatable events. The conquest of one disease after another, the considerable progress made against those diseases that remain, is a process to which one can at least intuitively apply probability concepts. It is on such a model that all projections, including those of this paper, are based.

The conquest of the barrier up to now set on total life span is another matter. It would involve a hitherto unheard of discovery in the field of cell biology, a onetime event. No use of past data can tell us anything about the probability that it will occur within a time that is relevant for social security--say within the next century.

Nonetheless we may experiment to see what would happen if it did come. Suppose that instead of moving upward the survivorship curve moved off to the right; that the aging process was slowed and in each year we aged only half a year. We can easily adapt

the life table to this condition and see how it would affect social security.

Suppose the normal age of retirement continued to be 65. TABLE 5 shows the ratio of persons of retired to working ages on that condition, and we can see that it gets to be above 2:1 towards the end of the 21st century. The main lesson to be learned here is that retirement age ultimately has to be counted back from the end of life rather than forward from birth.

No one knows the probability of such a discovery, but it is clearly greater than zero. If it occurs, the effect depends heavily on what people do with the extra years. Suppose that they insist on retiring at age 62 or 65, as now. After a transition period the adult population would divide into one third working, two thirds retired. If social security was to replace only half of the salary level, then each dollar earned by the members of the work force would have to be equally divided: half would go as social security tax, half left with the person who earned it, from which all other taxes would have to be paid.

A Policy in the Face of Uncertainty

The uncertainty shown in TABLE 3 is considerable; we cannot forecast the persons of working age by 2040 closer than the range 136 million to 210 million. Anyone who thinks that I am exaggerating the uncertainty may go back and look at earlier forecasts. P.K. Whelpton, one of the best demographers of the time, estimated in 1935, when the United States population was 127 million, that it would be 155 million by 1970; it was in fact 203 million. Numerous other examples show that this degree of

TABLE 5. PERSONS 65 AND OVER PER THOUSAND 20-64, ON THREE HYPOTHESES: CONTRAST OF HALVING DEATH RATES IN CONTINUATION OF PAST TRENDS WITH HALVING OF THE AGING PROCESS THROUGH AN UNPRECEDENTED DISCOVERY

YEAR	EXPECTED IMPROVEMENT	HALVING OF DEATH RATES	HALVING OF AGING
1980	199	199	199
2000	220	264	421
2020	302	353	723
2040	435	506	1196
2060	447	510	1622
2080	461	514	1981
2100	475	517	2239

Professor Hickman has shown that death rates at many ages have been going down by 2 percent per year in recent decades; that means they drop 50 percent in the course of 35 years. This has some effect on pension cost, but very different from slowing the aging process by half. The middle column of TABLE 5 shows how the cost of pensions would be affected by a further immediate halving of death rates; in the year 2100 the cost per $1000 would go from the expected $475 to $517, asmall increase, simply because for most ages the rates are already very low. The last column shows the dramatic effects of slowing the aging process by half, calculated by assigning to people the same probability of surviving two years that they normaily have of surviving one year. This doubling of the life span raises the expectation of life at birth to 147 years, as against the present tendency of diminishing rates that would take us only to 80 or 85 years.

ignorance of the future is typical.

And the uncertainty is increased greatly if we recognize even a small possibility of a breakthrough in slowing down the aging process; its effect on social security would be far greater than any now in sight.

In the face of such uncertainty the only possible recommendation is to build a reserve. The reserve would serve as a partial cushion against contingencies such as are here sketched; it would iron out the inequity between generations that will otherwise occur when the baby boom comes to pension age; it would make a financial contribution to the cost of social security through the interest it earned (if invested in the national debt, it could earn up to half of the present total expenditure on pensions). This is not to mention its favorable effect on capital accumulation.

APPENDIX

The Appendix tables provide more detail on the points summarized in TABLES 3 to 5. TABLE 6A gives the low forecast--low fertility, low mortality, low migration--and is least favorable to the social security program. TABLE 6B is the high projection and is most favorable. TABLE 7 goes further than the low projection and shows what would happen if death rates were halved, so that the expectation of life rose to 87 years. The last table supposes an extension of the life span through the control of aging, by which each of us would age as little in two years as we now do in one. The expectation of life would double, and the ratio of persons over 65 to those 20-64 would climb above 2 to 1.

TABLE 6A PROJECTION WITH LOW FERTILITY, LOW MORTALITY, AND LOW IMMIGRATION. Thousands of persons.

	1980	2000	2020	2040	2060	2080	2100
0-	16,344	14,318	12,616	10,984	9,699	8,654	7,773
5-	16,697	15,323	13,155	11,443	10,146	9,050	8,124
10-	18,241	16,171	13,595	11,948	10,611	9,444	8,474
15-	21,162	16,246	14,095	12,546	11,091	9,854	8,850
20-	21,313	16,834	14,859	13,186	11,574	10,302	9,266
25-	19,518	17,228	15,914	13,789	12,103	10,823	9,739
30-	17,558	18,722	16,746	14,233	12,620	11,307	10,156
35-	13,963	21,486	16,741	14,661	13,155	11,730	10,514
40-	11,668	21,448	17,165	15,276	13,657	12,084	10,837
45-	11,088	19,365	17,271	16,060	14,018	12,386	11,142
50-	11,709	17,065	18,377	16,581	14,205	12,672	11,415
55-	11,614	13,199	20,545	16,224	14,337	12,953	11,618
60-	10,086	10,568	19,827	16,160	14,558	13,137	11,712
65-	8,000	9,435	17,088	15,637	14,796	13,087	11,683
70-	7,578	9,124	14,101	15,759	14,591	12,741	11,533
75-	4,000	7,912	9,856	16,210	13,315	12,104	11,173
80-	3,000	5,608	6,759	13,792	11,928	11,214	10,453
85-	2,967	4,638	6,260	12,280	11,874	11,687	10,651
TOTAL	226506	254689	264969	256769	228278	205227	185112
LIFE EXPECTANCY	74.83	78.31	80.49	81.99	83.08	83.91	84.56
RECTANGULAR H	0.151	0.120	0.099	0.085	0.074	0.065	0.059
BIRTHS	0	2890	2541	2210	1949	1738	1561
NRR	0.78	0.79	0.79	0.79	0.79	0.80	0.80
RATE OF INCREASE	0.00	0.59	0.39	0.21	0.01	-0.10	-0.17
PERSONS 20-64	128517	155915	157444	136170	120227	107392	96397
PERSONS 65+	25545	36718	54064	73678	66503	60833	55492
RATIO 65+/20-64	198.77	235.50	343.38	541.07	553.14	566.46	575.66

TABLE 6B PROJECTION WITH HIGH FERTILITY, HIGH MORTALITY, AND HIGH IMMIGRATION Thousands of Persons.

	1980	2000	2020	2040	2060	2080	2100
0-	16,344	19,613	22,366	24,138	25,962	28,007	30,072
5-	16,697	20,531	22,524	23,947	25,926	28,015	30,042
10-	18,241	21,491	22,095	23,764	25,963	27,988	29,971
15-	21,162	21,484	21,483	23,899	26,070	27,954	29,943
20-	21,313	18,286	21,574	24,342	26,131	27,966	30,019
25-	19,518	18,871	22,723	24,745	26,192	28,185	30,283
30-	17,558	20,427	23,720	24,382	26,080	28,295	30,333
35-	13,963	23,069	23,516	23,596	26,036	28,227	30,129
40-	11,668	22,760	19,956	23,268	26,060	27,878	29,736
45-	11,088	20,232	19,790	23,662	25,733	27,226	29,245
50-	11,709	17,557	20,543	23,893	24,674	26,431	28,679
55-	11,614	13,423	22,200	22,920	23,205	25,698	27,939
60-	10,086	10,572	20,869	18,744	22,084	24,929	26,842
65-	8,000	9,215	17,434	17,612	21,452	23,668	25,320
70-	7,578	8,640	13,887	17,004	20,389	21,547	23,477
75-	4,000	7,199	9,332	16,487	17,875	18,749	21,312
80-	3,000	4,825	6,039	13,189	12,779	15,869	18,646
85-	2,967	4,041	5,512	11,484	12,441	15,910	18,217
TOTAL	226506	282236	335562	381076	415051	452542	490204
LIFE EXPECTANCY	71.89	75.82	78.35	80.12	81.42	82.42	83.21
RECTANGULAR H	0.174	0.142	0.120	0.103	0.090	0.080	0.072
BIRTHS	0	3969	4515	4864	5226	5633	6044
NRR	0.97	0.98	0.99	0.99	1.00	1.00	1.00
RATE OF INCREASE	0.00	1.11	0.99	0.87	0.76	0.69	0.65
PERSONS 20-64	128517	165197	194891	209551	226194	244834	263205
PERSONS 65+	25545	33920	52204	75776	84935	95743	106972
RATIO 65+/20-64	198.77	205.33	267.86	361.61	375.50	391.05	406.42

TABLE 7. PROJECTION WITH 50 PERCENT FURTHER FALL IN MORTALITY STARTING IMMEDIATELY Thousands of persons.

	1980	2000	2020	2040	2060	2080	2100
0-	16,344	17,085	17,449	17,180	17,006	16,949	16,888
5-	16,697	18,089	17,856	17,423	17,351	17,307	17,227
10-	18,241	19,013	17,909	17,687	17,725	17,635	17,537
15-	21,162	19,0[illegible]	17,911	18,152	18,134	17,972	17,885
20-	21,313	17,[illegible]49	18,409	18,785	18,527	18,359	18,307
25-	19,518	18,[illegible]67	19,579	19,366	18,947	18,884	18,846
30-	17,558	19,743	20,550	19,479	19,274	19,323	19,243
35-	13,963	22,51[illegible]	20,487	19,379	19,639	19,636	19,485
40-	11,668	22,390	18,832	19,621	20,019	19,781	19,628
45-	11,088	20,146	18,896	20,342	20,165	19,775	19,730
50-	11,709	17,772	[illegible],023	20,894	19,891	19,727	19,803
55-	11,614	13,865	22,287	20,442	19,442	19,754	19,794
60-	10,086	11,264	21,[illegible]44	18,427	19,307	19,782	19,618
65-	8,000	10,273	18,919	18,014	19,562	19,530	19,258
70-	7,578	10,266	16,050	18,453	19,528	18,794	18,787
75-	4,000	9,410	11,818	19,551	18,340	17,727	18,226
80-	3,000	7,276	8,790	17,661	15,560	16,696	17,420
85-	2,967	5,909	8,177	15,719	15,445	17,146	17,408
TOTAL	226506	279890	315586	336576	333860	334776	335090
LIFE EXPECTANCY	80.29	82.73	84.19	85.16	85.85	86.37	86.78
RECTANGULAR H	0.101	0.077	0.062	[illegible].052	0.045	0.039	0.035
BIRTHS	0	3435	3504	3[illegible]48	3411	3398	3385
NRR	0.89	0.90	0.90	0.[illegible]0	0.90	0.90	0.90
RATE OF INCREASE	0.00	1.06	0.83	0.6[illegible]	0.49	0.39	0.33
PERSONS 20-64	128517	163511	180707	176734	175211	175019	174454
PERSONS 65+	25545	43134	63754	8939[illegible]	88435	89892	91100
RATIO 65+/20-64	198.77	263.80	352.81	505.8[illegible]	504.73	513.61	522.20

The difference between the halving of mortality rates (such as has occurred in the United States during the past generation) and the halving of the aging process is shown by TABLES 7 and 8. TABLE 7 shows expectation of life up to 87 years, against up to 168 years in TABLE 8. In TABLE 8 the total population by the year 2040 would be 461 million, of whom 178 million are aged 20-64 and 213 million 65 and over! The relative number of aged in TABLE 8 continues to rise beyond the beginning of the 22nd century.

TABLE 8. EFFECT OF HALVING THE RATE OF AGING; PROJECTION IN WHICH THE PROBABILITY OF SURVIVING FIVE YEARS IS APPLIED TO TEN YEARS *Thousands of persons.*

0-	16,344	17,040	17,371	17,090	16,912	16,849	16,785
5-	16,697	18,058	17,786	17,348	17,269	17,216	17,131
10-	18,241	18,935	17,826	17,605	17,631	17,534	17,433
15-	21,162	18,968	17,862	18,087	18,051	17,882	17,790
20-	21,313	17,683	18,390	18,729	18,455	18,281	18,222
25-	19,518	18,223	19,596	19,335	18,904	18,829	18,780
30-	17,558	19,843	20,551	19,455	19,241	19,271	19,178
35-	13,963	22,669	20,503	19,411	19,642	19,611	19,446
40-	11,668	22,521	18,947	19,671	20,022	19,758	19,592
45-	11,088	20,346	19,097	20,485	20,239	19,821	19,754
50-	11,709	18,066	20,376	21,109	20,038	19,839	19,880
55-	11,614	14,291	22,965	20,849	19,785	20,030	20,011
60-	10,086	11,881	22,678	19,160	19,900	20,264	20,013
65-	8,000	11,195	20,408	19,200	20,602	20,374	19,970
70-	7,578	11,739	18,073	20,396	21,147	20,099	19,913
75-	4,000	11,595	14,283	22,920	20,845	19,804	20,061
80-	3,000	10,031	11,841	22,562	19,107	19,862	20,240
85-	2,967	7,942	11,131	20,280	19,116	20,530	20,322
90-	0	7,451	11,579	17,861	20,197	20,974	19,962
95-	0	3,929	11,406	14,096	22,659	20,647	19,645
100-	0	2,900	9,759	11,581	22,139	18,800	19,582
105-	0	2,850	7,706	10,865	19,874	18,788	20,221
110-	0	0	7,128	11,171	17,330	19,678	20,499
115-	0	0	3,748	10,984	13,660	22,057	20,166
120-	0	0	2,708	9,233	11,053	21,265	18,146
125-	0	0	2,650	7,270	10,350	19,063	18,114
130-	0	0	0	6,557	10,413	16,311	18,657
135-	0	0	0	3,434	10,209	12,829	20,877
140-	0	0	0	2,395	8,328	10,112	19,665
145-	0	0	0	2,330	6,529	9,438	17,585
150-	0	0	0	0	5,602	9,091	14,476
155-	0	0	0	0	2,915	8,871	11,344
160-	0	0	0	0	1,877	6,748	8,404
165-	0	0	0	0	1,807	5,251	7,799
170-	0	0	0	0	0	4,905	8,093
175-	0	0	0	0	0	2,539	7,866
TOTAL	226506	308156	386368	461468	531847	593221	635623
LIFE EXPECTANCY	146.61	154.06	158.80	162.07	164.48	166.31	167.76
RECTANGULAR H	0.163	0.132	0.110	0.094	0.082	0.073	0.066
BIRTHS	0	3444	3503	3441	3402	3387	3372
NRR	0.89	0.89	0.90	0.90	0.90	0.90	0.90
RATE OF INCREASE	0.00	1.55	1.34	1.19	1.07	0.97	0.86
PERSONS 20-64	128517	165523	183103	178203	176226	175705	174878
PERSONS 65+	25545	69633	132419	213135	285758	348036	391607
RATIO 65+/20-64	198.77	420.69	723.19	1196.02	1621.54	1980.80	2239.32

Mr. KEYFITZ. That is right, sir. So to me it is very impressive that the present troubles, however great they are, are not due to demographic causes, but that in addition to all these present troubles will be this demographic impact starting in the year 2000 and——

Senator CHAFEE. We have not seen anything yet?

Mr. KEYFITZ. That is what I am saying.

Senator CHAFEE. OK. Go ahead.

Mr. KEYFITZ. By the way, I will give you all this in writing before your deadline of the July 29.

Then the next table is the middle one, and the third one is what I call high variant. That is to say, the circumstances under which the population will be increasing rapidly through high births, and so the difficulties of the social security will be diminished by that.

And then in place of the figure of 519, you have a figure of 376.

Senator CHAFEE. That would be 3 to 1. Which do you think is the most realistic?

Mr. KEYFITZ. This is the range that the past suggests. I find it hard to answer your question, sir, but what I do say is that in planning for the social security future, one should assume if not the very worst, something a little worse than the expected value, and then, as Dr. Manton said, if you are wrong, the worst that happens is that a reserve is built up that you did not plan for, and that is not a terrible thing to happen.

Senator CHAFEE. It is not terrible to have a surplus once in a while.

Mr. KEYFITZ. That is right, whereas——

Senator CHAFEE. That is un-American to say that.

Mr. KEYFITZ. If you are wrong on the other side, then you have what we have seen over the last few years: constant revision and steady erosion of public confidence. The peak of the baby boom, which is now around age 25 or so, gradually moves down as those people get older, and while the baby boom are in the working ages, they contribute to social security in a positive way. Once they get past age 65, their effect becomes negative.

Senator CHAFEE. Yes, I must say I have a little trouble following that.

Mr. KEYFITZ. Table 2 shows these are the bump you see in the column for 1980 at about age 20.

Senator CHAFEE. What column are we on?

Mr. KEYFITZ. Column 1980. You will see a peak there of 21,313.

Senator CHAFEE. Yes.

Mr. KEYFITZ. That is the baby boom.

Senator CHAFEE. Oh, I see. OK. Is there something significant in your other tables?

Mr. KEYFITZ. I have also calculated the implicit rate of return on social security. Everyone knows that at the start of the scheme, people were very well treated by it, and many, including people in my generation, would get five times as much as they put in, but that has to be paid for and in a stationary condition the implicit rate of return is going to be low and even negative for later cohorts. The cohort born in 1960 will receive 1.053 percent per annum return on what they previously had put in, so they are still getting a positive return, but the return gradually diminishes and

becomes negative for the cohort born about the year 2000, supposing a stationary condition of the population and of the economy.

This is what would be considered by a State employee, for example, who has the choice between going into social security and investing in some private scheme.

Senator CHAFEE. Try a gentler word than scheme. How about plan or program?

Mr. KEYFITZ. All right. If you were in a private plan in which your premiums were saved up and accumulated with interest, if the rate of interest was zero, you would have to pay $300 per $1,000 of annuity at age 65.

But if you get 3 percent interest, then you would only pay $104. Now, my point in introducing this is that interest would cut the cost of pensions, would cut the annual premium by two-thirds. This is not a new discovery of mine. In Sweden, they have now become sufficiently disillusioned with the pay-as-you-go system that they have introduced a mandatory funded scheme on top of the universal unfunded one, so that instead of expanding the unfunded scheme as we have been doing successively, they put a cap on it and made further provision for old age in the form of a mandatory savings plan.

Senator CHAFEE. OK. That is very interesting. I have enough here today to wrestle with without even getting into the funding and the alternatives of going into separate programs. But I appreciate those statistics.

[The tables prepared by Mr. Keyfitz follow:]

TABLE 1 UNITED STATES POPULATION PROJECTION FROM 1980, WITH VARIANTS GIVING 95 PERCENT CONFIDENCE LIMITS

LOW VARIANT	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
0	16,344	14,847	14,957	14,219	13,242	12,429	11,809	11,338	10,879	10,337	9,781	9,290
5	16,697	16,368	14,879	14,992	14,258	13,286	12,476	11,858	11,389	10,932	10,392	9,837
10	18,241	16,736	16,410	14,925	15,039	14,307	13,337	12,529	11,913	11,444	10,989	10,449
15	21,162	18,252	16,757	16,436	14,959	15,075	14,347	13,381	12,577	11,963	11,497	11,043
20	21,313	21,114	18,232	16,754	16,441	14,977	15,097	14,377	13,418	12,619	12,010	11,547
25	19,518	21,273	21,088	18,235	16,773	16,468	15,016	15,140	14,427	13,475	12,682	12,078
30	17,558	19,464	21,219	21,046	18,217	16,770	16,472	15,032	15,159	14,452	13,507	12,720
35	13,963	17,464	19,368	21,122	20,961	18,160	16,728	16,438	15,010	15,141	14,441	13,504
40	11,668	13,826	17,302	19,200	20,952	20,806	18,042	16,631	16,350	14,940	15,075	14,385
45	11,088	11,464	13,602	17,037	18,927	20,673	20,548	17,837	16,456	16,190	14,804	14,946
50	11,709	10,759	11,152	13,258	16,634	18,508	20,243	20,147	17,511	16,174	15,927	14,578
55	11,614	11,158	10,296	10,709	12,767	16,056	17,903	19,619	19,561	17,031	15,754	15,534
60	10,086	10,768	10,412	9,660	10,094	12,080	15,242	17,048	18,732	18,723	16,338	15,145
65	8,000	9,018	9,718	9,472	8,848	9,300	11,186	14,177	15,920	17,556	17,604	15,408
70	7,578	6,787	7,756	8,455	8,324	7,844	8,307	10,057	12,821	14,473	16,036	16,150
75	4,000	5,852	5,356	6,233	6,902	6,887	6,568	7,028	8,588	11,039	12,554	14,005
80	3,000	2,690	4,066	3,827	4,561	5,157	5,241	5,079	5,514	6,823	8,870	10,193
85	2,967	3,001	2,690	4,066	3,828	4,562	5,157	5,241	5,080	5,514	6,823	8,870
T=	226506	230841	235260	239646	241727	243344	243719	242957	241305	238826	235086	229683
E0	71.28	72.47	73.52	74.45	75.29	76.04	76.71	77.33	77.89	78.40	78.87	79.31
H=	0.179	0.170	0.161	0.154	0.147	0.140	0.134	0.129	0.124	0.119	0.115	0.111
bi	0	3017	3035	2882	2682	2515	2388	2291	2197	2086	1973	1873
NR	0.73	0.73	0.73	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
WO	128517	137290	142671	147022	151767	154497	155292	152268	146625	138744	130539	124436
PE	25545	27347	29585	32053	32463	33750	36459	41583	47922	55405	61889	64627
ER	0.00	0.38	0.38	0.38	0.33	0.29	0.24	0.20	0.16	0.12	0.07	0.03
PR	198.77	199.19	207.37	218.01	213.90	218.45	234.77	273.09	326.83	399.33	474.10	519.36

CV= 0.166 0.179 0.783 IM= 151.658 HIST. MEANS: 21.6128 8.99149 97.8745 AA= 10
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25-513 O—83—8

TABLE 1 UNITED STATES POPULATION PROJECTION FROM 1980, WITH VARIANTS GIVING 95 PERCENT CONFIDENCE LIMITS--CONT'D

MEDIUM VARIANT

	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
0	16,344	18,004	18,439	17,822	17,012	16,780	17,119	17,460	17,412	17,115	16,905	16,924
5	16,697	16,634	18,294	18,731	18,118	17,311	17,082	17,422	17,764	17,718	17,422	17,214
10	18,241	16,980	16,919	18,578	19,017	18,405	17,600	17,372	17,713	18,056	18,010	17,715
15	21,162	18,532	17,278	17,221	18,879	19,320	18,713	17,911	17,685	18,028	18,371	18,327
20	21,313	21,459	18,852	17,612	17,560	19,217	19,661	19,060	18,265	18,043	18,387	18,732
25	19,518	21,706	21,862	19,277	18,050	18,004	19,659	20,106	19,511	18,723	18,505	18,851
30	17,558	19,790	21,975	22,140	19,575	18,359	18,319	19,972	20,421	19,833	19,050	18,836
35	13,963	17,696	19,923	22,106	22,279	19,736	18,533	18,498	20,149	20,600	20,019	19,243
40	11,668	14,000	17,708	19,929	22,105	22,290	19,777	18,591	18,564	20,210	20,665	20,093
45	11,088	11,607	13,919	17,590	19,799	21,967	22,166	19,696	18,535	18,518	20,158	20,618
50	11,709	10,884	11,415	13,696	17,312	19,502	21,653	21,873	19,465	18,339	18,337	19,966
55	11,614	11,288	10,534	11,077	13,312	16,848	19,008	21,134	21,380	19,058	17,981	17,998
60	10,086	10,928	10,680	10,015	10,570	12,737	16,157	18,270	20,356	20,635	18,434	17,424
65	8,000	9,200	10,045	9,884	9,324	9,888	11,961	15,221	17,267	19,293	19,612	17,567
70	7,578	6,978	8,115	8,946	8,878	8,438	9,004	10,948	13,996	15,945	17,886	18,248
75	4,000	6,102	5,724	6,757	7,546	7,575	7,273	7,830	9,591	12,343	14,149	15,960
80	3,000	2,872	4,495	4,319	5,200	5,909	6,024	5,864	6,388	7,906	10,268	11,872
85	2,967	3,008	2,881	4,503	4,328	5,208	5,917	6,032	5,872	6,396	7,914	10,275
T=	226506	237668	249058	260203	268864	277495	285626	293260	300334	306758	312071	315862
E0	73.31	74.42	75.40	76.26	77.03	77.71	78.33	78.89	79.40	79.86	80.29	80.68
H=	0.163	0.154	0.146	0.138	0.132	0.125	0.120	0.115	0.110	0.105	0.101	0.098
bi	0	3650	3734	3605	3438	3389	3456	3523	3511	3450	3406	3409
NR	0.88	0.88	0.88	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.90
WO	128517	139358	146868	153441	160563	168661	174933	177200	176645	173959	171535	171761
PE	25545	28161	31260	34410	35276	37018	40179	45895	53114	61883	69828	73922
ER	0.00	0.97	0.95	0.93	0.86	0.82	0.78	0.74	0.71	0.68	0.64	0.61
PR	198.77	202.07	212.84	224.25	219.70	219.48	229.68	259.00	300.68	355.73	407.07	430.38

CV= 0.166 0.179 0.783 IM= 700 HIST. MEANS: 21.6128 8.99149 97.8745 AA= 10
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TABLE 1 UNITED STATES POPULATION PROJECTION FROM 1980, WITH VARIANTS GIVING 95 PERCENT CONFIDENCE LIMITS--CONT'D

HIGH VARIANT

	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
0	16,344	21,229	22,093	21,688	21,168	21,790	23,506	25,047	25,687	25,914	26,454	27,520
5	16,697	16,900	21,779	22,644	22,242	21,726	22,348	24,064	25,605	26,245	26,474	27,015
10	18,241	17,223	17,427	22,303	23,169	22,769	22,254	22,877	24,593	26,133	26,774	27,004
15	21,162	18,812	17,800	18,007	22,876	23,743	23,346	22,834	23,458	25,173	26,713	27,355
20	21,313	21,804	19,472	18,470	18,681	23,538	24,407	24,015	23,509	24,135	25,849	27,388
25	19,518	22,138	22,636	20,321	19,329	19,544	24,389	25,260	24,874	24,373	25,000	26,713
30	17,558	20,116	22,732	23,236	20,937	19,953	20,172	25,005	25,878	25,497	25,001	25,630
35	13,963	17,927	20,480	23,091	23,601	21,319	20,346	20,568	25,388	26,262	25,887	25,397
40	11,668	14,173	18,115	20,660	23,264	23,781	21,523	20,563	20,791	25,591	26,468	26,101
45	11,088	11,751	14,237	18,146	20,678	23,271	23,798	21,573	20,632	20,867	25,639	26,519
50	11,709	11,010	11,679	14,138	17,998	20,509	23,083	23,623	21,448	20,534	20,780	25,508
55	11,614	11,419	10,774	11,450	13,866	17,655	20,136	22,681	23,237	21,130	20,255	20,514
60	10,086	11,090	10,953	10,378	11,059	13,413	17,098	19,532	22,032	22,610	20,599	19,776
65	8,000	9,385	10,380	10,310	9,818	10,501	12,769	16,312	18,677	21,114	21,715	19,829
70	7,578	7,174	8,489	9,460	9,462	9,066	9,746	11,896	15,247	17,516	19,862	20,487
75	4,000	6,361	6,114	7,321	8,244	8,323	8,043	8,706	10,688	13,769	15,895	18,104
80	3,000	3,065	4,966	4,869	5,921	6,760	6,911	6,755	7,382	9,136	11,853	13,778
85	2,967	3,016	3,082	4,982	4,885	5,937	6,776	6,927	6,771	7,398	9,151	11,868
T=	226506	244593	263209	281473	297196	313597	330649	348238	365896	383398	400369	416505
EO	75.56	76.57	77.45	78.23	78.91	79.52	80.07	80.56	81.01	81.41	81.78	82.12
H=	0.144	0.136	0.128	0.121	0.114	0.109	0.103	0.099	0.094	0.090	0.087	0.083
bi	0	4293	4464	4378	4271	4393	4737	5045	5172	5216	5323	5536
NR	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.05	1.05	1.05
WO	128517	141428	151079	159890	169413	182984	194950	202819	207788	210999	215477	223545
PE	25545	29001	33031	36942	38328	40587	44245	50596	58765	68932	78476	84067
ER	0.00	1.55	1.51	1.46	1.37	1.31	1.27	1.24	1.21	1.18	1.15	1.11
PR	198.77	205.06	218.64	231.04	226.24	221.81	226.95	249.46	282.81	326.69	364.20	376.06

CV= 0.166 0.179 0.783 IM= 1248.34 HIST. MEANS: 21.6128 8.99149 97.8745 AA= 10
4.97113 .0408066 105.494 28 106 92 q= 21

TABLE 1A UNITED STATES POPULATION PROJECTION FROM 1980, SUCCESSIVE DIFFERENCES

MEDIUM VARIANT

	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
0	16,344	1,640	242	-642	-700	-145	281	207	-109	-256	-149	14
5	16,697	-63	1,639	245	-638	-696	-143	282	208	-108	-254	-147
10	18,241	-1,261	-61	1,639	246	-636	-694	-142	283	209	-107	-253
15	21,162	-2,630	-1,253	-57	1,638	248	-632	-691	-140	284	210	-105
20	21,313	146	-2,607	-1,240	-51	1,637	252	-626	-685	-136	286	212
25	19,518	2,188	156	-2,585	-1,227	-46	1,635	256	-619	-679	-132	288
30	17,558	2,232	2,186	164	-2,565	-1,216	-40	1,633	259	-613	-673	-129
35	13,963	3,733	2,228	2,182	173	-2,542	-1,203	-35	1,630	263	-606	-667
40	11,668	2,332	3,708	2,221	2,177	184	-2,512	-1,186	-27	1,626	267	-597
45	11,089	519	2,312	3,671	2,209	2,167	199	-2,469	-1,162	-17	1,620	274
50	11,709	-825	531	2,281	3,616	2,190	2,151	220	-2,407	-1,127	-2	1,610
55	11,614	-326	-754	543	2,235	3,536	2,160	2,126	246	-2,321	-1,078	17
60	10,086	842	-248	-665	556	2,167	3,419	2,114	2,086	279	-2,201	-1,010
65	8,000	1,200	845	-161	-560	565	2,072	3,260	2,046	2,026	318	-2,044
70	7,578	-600	1,137	831	-68	-440	567	1,944	3,048	1,949	1,941	361
75	4,000	2,102	-378	1,033	789	29	-302	557	1,761	2,751	1,806	1,811
80	3,000	-128	1,623	-176	881	708	115	-160	524	1,518	2,362	1,604
85	2,967	41	-128	1,623	-176	881	708	115	-160	524	1,517	2,362
T=	226506	11141	11176	10906	8535	8591	8033	7404	6782	6174	5125	3600
E0	73.31	74.42	75.40	76.26	77.03	77.71	78.33	78.89	79.40	79.86	80.29	80.68
H=	0.163	0.154	0.146	0.138	0.132	0.125	0.120	0.115	0.110	0.105	0.101	0.098
bi	0	3645	3690	3557	3413	3381	3436	3475	3452	3399	3367	3369
NR	0.88	0.88	0.88	0.88	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
WO	128517	139358	146868	153441	160563	168640	174701	176732	176052	173328	170808	170806
PE	25545	28161	31260	34410	35276	37018	40179	45895	53114	61883	69828	73922
ER	0.00	0.96	0.94	0.92	0.85	0.81	0.77	0.73	0.70	0.67	0.63	0.60
PR	198.77	202.07	212.84	224.25	219.70	219.51	229.99	259.69	301.70	357.03	408.81	432.78

CV= 0.166 0.179 0.783 IM= 700 HIST. MEANS: 21.6128 8.99149 97.8745 AA= 10 FF= .727421
4.92652 .055 59.1549 28 106 92 q= 21

TABLE 2. IMPLICIT PERCENTAGE RATE OF RETURN ON SOCIAL SECURITY PAYMENTS FOR SUCCESSIVE BIRTH COHORTS WITH FIVE LEVELS OF BIRTHS

	FRACTION OF 1979 BIRTH RATES				
	0.50	0.75	1.00	1.25	1.50
1960	0.890	0.978	1.053	1.117	1.173
1965	0.658	0.817	0.946	1.054	1.146
1970	0.324	0.592	0.803	0.975	1.118
1975	-0.088	0.329	0.648	0.901	1.108
1980	-0.546	0.048	0.491	0.838	1.118
1985	-1.035	-0.247	0.327	0.771	1.129
1990	-1.405	-0.506	0.156	0.672	1.091
1995	-1.664	-0.716	0.001	0.570	1.037
2000	-1.835	-0.874	-0.117	0.495	1.006
2005	-1.944	-0.983	-0.195	0.459	1.013
2010	-1.982	-1.039	-0.229	0.462	1.055
2015	-1.977	-1.055	-0.227	0.492	1.119
2020	-1.931	-1.045	-0.216	0.519	1.164
2025	-1.852	-1.023	-0.211	0.521	1.168
2030	-1.736	-0.989	-0.213	0.500	1.133
2035	-1.634	-0.963	-0.214	0.491	1.124
2040	-1.545	-0.941	-0.213	0.491	1.128
2045	-1.460	-0.919	-0.210	0.492	1.132
2050	-1.374	-0.893	-0.207	0.488	1.127

TABLE 3. IMPLICIT PERCENTAGE RATE OF RETURN ON SOCIAL SECURITY PAYMENTS FOR SUCCESSIVE BIRTH COHORTS SUPPOSING GIVEN FRACTION OF 1979 MORTALITY UNIFORM AT ALL AGES

COHORT	FRACTION OF 1979 MORTALITY				
	0.50	0.75	1.00	1.25	1.50
1960	1.381	1.216	1.053	0.890	0.729
1965	1.184	1.064	0.946	0.830	0.716
1970	0.974	0.888	0.803	0.721	0.641
1975	0.775	0.711	0.648	0.587	0.528
1980	0.592	0.541	0.491	0.443	0.395
1985	0.415	0.371	0.327	0.283	0.239
1990	0.242	0.199	0.156	0.113	0.070
1995	0.087	0.044	0.001	-0.042	-0.085
2000	-0.035	-0.076	-0.117	-0.159	-0.199
2005	-0.120	-0.157	-0.195	-0.232	-0.270
2010	-0.163	-0.195	-0.229	-0.262	-0.295
2015	-0.168	-0.198	-0.227	-0.257	-0.287
2020	-0.158	-0.187	-0.216	-0.245	-0.274
2025	-0.152	-0.181	-0.211	-0.240	-0.270
2030	-0.152	-0.182	-0.213	-0.243	-0.274
2035	-0.153	-0.183	-0.214	-0.244	-0.275
2040	-0.154	-0.183	-0.213	-0.242	-0.272
2045	-0.153	-0.181	-0.210	-0.238	-0.267
2050	-0.151	-0.179	-0.207	-0.236	-0.264

TABLE 4. PERCENTAGE RATE OF RETURN ON SOCIAL SECURITY PAYMENTS FOR SUCCESSIVE BIRTH COHORTS SUPPOSING GIVEN FRACTION OF 1979 MORTALITY AT AGES OVER 65 ONLY

COHORT	FRACTION OF 1979 MORTALITY				
	0.50	0.75	1.00	1.25	1.50
1960	1.319	1.187	1.053	0.918	0.782
1965	1.105	1.025	0.946	0.869	0.793
1970	0.894	0.848	0.803	0.761	0.721
1975	0.701	0.674	0.648	0.624	0.601
1980	0.524	0.508	0.491	0.475	0.460
1985	0.353	0.340	0.327	0.313	0.300
1990	0.185	0.171	0.156	0.141	0.127
1995	0.032	0.017	0.001	-0.014	-0.030
2000	-0.090	-0.104	-0.117	-0.131	-0.145
2005	-0.174	-0.185	-0.195	-0.205	-0.215
2010	-0.217	-0.223	-0.229	-0.234	-0.240
2015	-0.223	-0.225	-0.227	-0.230	-0.232
2020	-0.214	-0.214	-0.216	-0.217	-0.219
2025	-0.206	-0.208	-0.211	-0.213	-0.216
2030	-0.205	-0.209	-0.213	-0.217	-0.221
2035	-0.205	-0.209	-0.214	-0.218	-0.223
2040	-0.206	-0.209	-0.213	-0.216	-0.220
2045	-0.204	-0.207	-0.210	-0.213	-0.216
2050	-0.202	-0.205	-0.207	-0.210	-0.214

TABLE 5. PERCENTAGE RATE OF RETURN ON SOCIAL SECURITY PAYMENTS FOR SUCCESSIVE BIRTH COHORTS SUPPOSING GIVEN NUMBERS OF IMMIGRANTS (000's)

COHORT	THOUSANDS OF IMMIGRANTS				
	350	525	700	875	1050
1960	0.995	1.025	1.053	1.080	1.106
1965	0.871	0.909	0.946	0.981	1.015
1970	0.710	0.758	0.803	0.847	0.888
1975	0.538	0.595	0.648	0.699	0.747
1980	0.370	0.433	0.491	0.547	0.599
1985	0.200	0.265	0.327	0.384	0.439
1990	0.026	0.093	0.156	0.215	0.270
1995	-0.129	-0.061	0.001	0.060	0.114
2000	-0.248	-0.180	-0.117	-0.060	-0.006
2005	-0.324	-0.256	-0.195	-0.138	-0.086
2010	-0.356	-0.289	-0.229	-0.173	-0.123
2015	-0.353	-0.287	-0.227	-0.174	-0.125
2020	-0.340	-0.274	-0.216	-0.163	-0.116
2025	-0.334	-0.268	-0.211	-0.159	-0.113
2030	-0.336	-0.270	-0.213	-0.162	-0.117
2035	-0.336	-0.271	-0.214	-0.164	-0.120
2040	-0.334	-0.269	-0.213	-0.164	-0.121
2045	-0.330	-0.265	-0.210	-0.162	-0.120
2050	-0.327	-0.262	-0.207	-0.160	-0.119

TABLE 3 ANNUAL PAYMENT FROM AGE 20 UNTIL RETIREMENT FOR AN ANNUITY OF $1000, AT VARIOUS RATES OF INTEREST AND AGES AT RETIREMENT

PC	55	60	65	70	75
0.0	624.98	438.76	300.05	196.24	119.62
0.2	586.29	410.95	280.48	183.00	111.22
0.4	549.96	384.80	262.07	170.54	103.32
0.6	515.86	360.23	244.75	158.83	95.90
0.8	483.85	337.13	228.48	147.82	88.94
1.0	453.80	315.44	213.19	137.48	82.41
1.2	425.59	295.07	198.83	127.78	76.30
1.4	399.11	275.94	185.35	118.69	70.58
1.6	374.26	257.99	172.71	110.18	65.24
1.8	350.93	241.14	160.86	102.21	60.25
2.0	329.04	225.33	149.75	94.76	55.60
2.2	308.49	210.51	139.35	87.79	51.27
2.4	289.21	196.62	129.62	81.29	47.23
2.6	271.11	183.59	120.51	75.23	43.49
2.8	254.13	171.38	112.00	69.57	40.00
3.0	238.19	159.95	104.04	64.30	36.77
3.2	223.24	149.24	96.61	59.40	33.78
3.4	209.21	139.22	89.68	54.84	31.01
3.6	196.04	129.84	83.20	50.60	28.45
3.8	183.70	121.06	77.17	46.67	26.08
4.0	172.11	112.84	71.54	43.02	23.89

WITH LIFE EXPECTATION 80 YEARS

PC	55	60	65	70	75
0.0	778.65	565.72	403.59	278.04	180.29
0.2	728.32	528.68	376.75	259.20	167.81
0.4	681.24	493.95	351.54	241.49	156.06
0.6	637.20	461.38	327.86	224.82	145.00
0.8	595.98	430.86	305.63	209.17	134.61
1.0	557.42	402.27	284.79	194.48	124.84
1.2	521.35	375.48	265.24	180.69	115.69
1.4	487.59	350.39	246.92	167.77	107.11
1.6	456.01	326.90	229.77	155.68	99.08
1.8	426.47	304.91	213.71	144.36	91.58
2.0	398.83	284.34	198.68	133.77	84.57
2.2	372.96	265.09	184.63	123.89	78.04
2.4	348.77	247.09	171.50	114.66	71.95
2.6	326.13	230.25	159.24	106.05	66.28
2.8	304.95	214.52	147.79	98.03	61.01
3.0	285.14	199.81	137.10	90.56	56.12
3.2	266.61	186.07	127.14	83.61	51.57
3.4	249.27	173.24	117.85	77.15	47.36
3.6	233.05	161.25	109.20	71.15	43.47
3.8	217.88	150.06	101.14	65.57	39.86
4.0	203.69	139.62	93.64	60.40	36.53

Senator CHAFEE. Why do we not hear from Dr. Walford, and then I will have some questions perhaps for each of you.

STATEMENT OF ROY L. WALFORD, M.D., PROFESSOR OF PATHOLOGY, UNIVERSITY OF CALIFORNIA AT LOS ANGELES

Dr. WALFORD. I have some slides to illustrate my talk, Senator.

In considering the biology of increase in lifespan, one must understand different mortality curves, and I will discuss two parameters of these curves. One is the 50-percent survival or average lifespan, and the other is maximum lifespan. These can be illustrated here. These are survival curves of ancient Rome, U.S. 1900 and 1960. The horizontal axis shows the aging years, and the vertical axis the percent survival.

One sees that in ancient Rome, average life expectancy was about 22 years. Half the population had died by then. U.S.A. 1900 was around 50 years, and 1960 or so it was more, and today it is around 73 years, lumping men and women. This is 50-percent survival. This has been increasing throughout the centuries substantially. This increase has been due to better personal hygiene, better public health measures, but it has not been due to a retardation of the aging process.

The other parameter that I want to introduce is that of maximum lifespan. That is the age to which a small percentage of the population reaches. It is genetically determined for each species. For humans it is about 110 years. A few people in ancient Rome reached this. A few people did in 1900. A few people still do today, but nobody either then or now has ever lived substantially longer than 110. So this is more or less fixed.

As we increase life expectancy or average survival, we slowly rotate the survival curve around this fixed 100- to 110-year point. This kind of increase, due to curing diseases, we can refer to as a curve-squaring technology. Now, the increase in average lifespan has been due to change in disease patterns, and this gives us the disease patterns of 1860 and 1970. You can see in 1860 the main killer disease was tuberculosis. Twenty percent of people died of that. Hardly anybody dies of that any more. The whole pattern of diseases has changed. In 1970 it was much different, with heart disease, cancer, and stroke being the major killers.

Thus we have shifted the 50-percent survival by this change in disease patterns. Now, again looking at this curve, if we cure all major diseases that mankind is now subjected to, for example, heart disease, cancer, stroke, maturity onset, diabetes, what can we expect the survival curve to look like? This is shown here as the theoretical limits of biological longevity if all diseases are wiped out, and one can calculate that the average lifespan for 50-percent survival then would be about 85 years.

This presupposes that we have not done anything about retarding the basic aging process. So that the 100- to 110-year point still is fixed, and we create this rectangular rising technology. One may ask, "What will people die of if there are no diseases around any more?" One can understand this if you look at the survival curves of people who are very old. With aging, what happens is that people are increasingly susceptible to smaller and smaller environ-

mental insults, so the main cause of death in very old people is accidents, and this is illustrated here by showing a couple of survival curves.

On the right is the curve for very old people, and on the left the curve for restaurant drinking glasses. Drinking glasses, of course, do not age in the biological sense, but you can construct a mortality curve for them. They are broken at a certain rate. And these comparable mortality curves show what would happen to humans if there were no diseases any more. They would still die off, and you would get that theoretical survival curve that I showed previously.

Now, what will happen if we have a span-extending technology in which the rate of aging is retarded and people live much longer. The 110-year point is stretched out in this hypothetical curve to, say, 140. Let us first of all predict or try to predict whether this is possible. It is difficult to make that kind of prediction, of course. Experts often—it is characteristic of experts in any specialty to underpredict the rate of advance in their field.

For example, in 1933 we are told by C. P. Snow in his book, "The Physicist," that Einstein, Nils Bohr, and Lord Rutherford, the three greatest physicists of the first half of this century, all predicted that we would never get power from the atom. They were proved wrong merely 12 years later by the bomb going off. In 1950, a bevy of experts from the Government predicted that by 1970 there would be about 100 large-scale main frame computers in the country. These were computer experts. In fact, by 1970 there were 200,000.

Long-term predictions are very difficult because you cannot predict the rate of scientific advance. Predictions can be wrong in either direction, of course. I believe that the chances of our achieving substantial extension of maximum lifespan by retardation of the aging process in the reasonably near future; that is, before the turn of the century, are quite good.

I think this is so for several reasons. One is that we are now in the age of not only the information revolution but of the biological revolution. Biology on a broad front is advancing at a very rapid rate. Aging research is now part of mainstream biology. It used to be many years ago kind of a kooky area, but this is no longer true, and with the establishment of the National Institute on Aging in 1976, aging biology has become mainline biology and is advancing very rapidly.

Another reason for my predicting that we will achieve extension of maximum life span in the not too distant future is that it is already possible to do this. For example, I show you here some survival curves on three different species of animals, rats, mice, and a unicellular organism in which the normal curve is shown as the dotted line, and the curve that one can produce by a restricted kind of nutritional regime is shown in the solid line. There is obviously a substantial increase in maximum survival in these curves. So it is possible to do this now, although this method is not very applicable to large-scale human use, although I think it would work in humans.

It is possible to do it now: So the question is no longer "Whether it is possible," but how easy, and when it will be of large-scale use.

Some more examples just to show you. These are mice—two on and two not on such a restricted regime. All of these mice are 40 months old. On the right you see normally fed mice. These are the last 2 survivors of a colony of 100. One can see that they have gray hair. They don't take care of themselves very well. Their rear ends are stuck with material from the cages. On the left are mice that have been dietarily lifespan prolonged. Half of the original colony of 100 are still alive at 40 months of age.

Here you see the oldest mouse in the world. This is a 54-month old mouse, equivalent in human terms to 148 years of age. It is not a question any more of whether it is possible, but when and how we will extend human lifespan. This is a little bit like asking no longer whether we will colonize Mars, but when and how.

Senator CHAFEE. What is the quality of life of the mouse?

Dr. WALFORD. I will discuss that in the next slide. If you extend maximum life span, we must not think of this as adding old years onto old, but what happens is that you stretch out the period of youth and middle age, so that if it is translated to human use, you see that in an extended life span, a person of 60 is physiologically and in mental and physical prowess equivalent to one who is 40, so that you extend youth and middle age. You do not do very much to the old period.

Now, if you extend other things in the survival curve, let me point out two other parameters. One is the age-specific incidence of the diseases of aging, cancer, heart disease, and stroke. These are shown under the two little age-specific mortality peaks, P and P prime. As you retard the rate of aging and extend maximum lifespan, the diseases of aging, which are not the cause of aging but are to some extent secondary to the increasing vulnerability that comes with aging, these are postponed so that heart disease and cancer might still occur, but at a much later age.

The second parameter is the number of people who would be senile or debilitated in a life-extended population.

Senator CHAFEE. We have got some time constraints here. How long do you think your presentation will be?

Dr. WALFORD. I think about 3 minutes.

Senator CHAFEE. Good. OK, fine.

Dr. WALFORD. The number of debilitated people in the population shown under the curves E will still be present, but their percent in the population, shown in E prime, will be less in a life extended population.

As you extend average lifespan; that is, in a curve squaring technology, what you do is increase the number of people in the advanced age period. This is shown in the slide by the time to run the New York marathon, so more and more people in the population will take a longer time to run it. You are creating by a curve-squaring technology an increasing number of functionally old people in the population.

The economic results from increasing only average life span by curing diseases are shown here on the left side. These are predicted from a study by Gori and Richter in "Science," and they predict with that, and I think this agrees in general with the conclusions of Mr. Bayo, a 5-percent decrease in gross national product, a 32-

percent decrease in housing starts, an increase in unemployment, an increase in unemployment insurance benefits.

Curing diseases has a bad economic potential for the population.

Now, if you extend maximum lifespan by retarding the rate of aging, you get people that are running the New York marathon at a much younger age. In other words, people that are 90 will have the physical prowess and so forth of those who are 60. You must make this distinction between functional age and chronologic age. Making that distinction, there is only one formal study in the literature of the effects of lifespan extending technology on economics of the population.

This is by Larry Kotlikoff, professor of economics at Yale, in which he predicts an increase in capital intensity, an increase in the ratio of productive to nonproductive persons, and an increase in average consumption over the lifetime.

Thus, one can predict, one, that we will probably get an increase in maximum lifespan in the not too distant future. This will have very positive effects on economic and social structure as opposed to merely increasing average lifespan by curing disease. The main problem I see therefore is to get over the hump of having numbers of functionally old people in the very near future. In the somewhat later future, these trends will be reversed as we retard aging, and I think we have less to worry about, social security and so forth, in 2020. We have something to worry about in 1990.

[The prepared statement of Dr. Walford follows:]

STATEMENT BY ROY L. WALFORD, M.D., Professor of Pathology, UCLA SCHOOL OF MEDICINE, LOS ANGELES, FOR THE U.S. SENATE FINANCE COMMITTEE, JULY 15, 1983.

I shall discuss certain effects on society that may result from continuing advances in general medical research on the one hand (advances leading to cures of major diseases, with extension of average life span or life expectancy), and of gerontological research on the other hand (leading to retardation of the rate of aging, with extension of maximum life span). I will also discuss the likelihood that extension of maximum life span will in fact be achieved before the end of this century, with the possibility that individuals now alive may enjoy life spans stretching out to 120 to 140 years, or even more.

In dealing with these concepts it is important to understand the terms "average life span" and "maximum life span." Look at Figure 1.

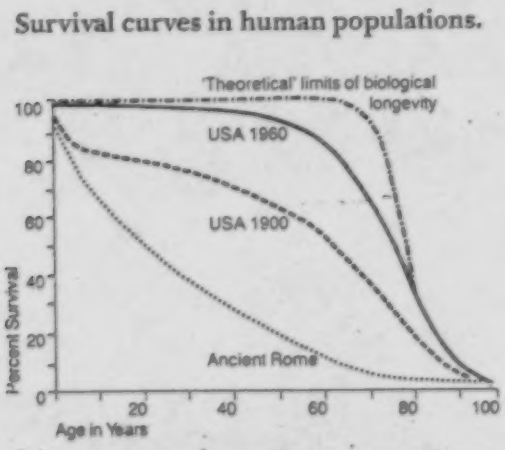

Fig. 1 Survival curves in human populations: ancient Rome, USA 1900 and 1960, and the curve resulting if all diseases were cured but the basic aging process still continuing ("theoretical" limits...).

"Average life span" or 50% survival is the age by which half the original population has died off. We see that it has increased throughout the centuries, for example from 22 years in ancient Rome, to 50-60 years in 1900, to around 73 years of age today. This has been brought about by improved personal hygiene, better water supply, enhanced public health measures ... but it does not signify any retardation of the aging process. The average life span is greatly influenced by environment and general medical care, but maximum life span is not so influenced. We can calculate that if all major diseases were cured, but the basic rate of aging remained the same, the average life span would increase to no more than the age of 85.

"Maximum life span", as the term implies, is the age to which the longest lived few remaining survivors of any species attain. It is more or less genetically fixed for each species, and among warm-blooded animals varies from perhaps a year and a half in shrews to 45 years in chimpanzees, to 110 in humans. Maximum life span tends to be independent of the environment and can only be budged by methods which influence the basic rate of aging. In ancient times a few people lived to reach 110; a few people still do today; but nobody then or now ever lives substantially longer. Differences in environment and levels of civilization have not heretofore influenced maximum life span.

If we cure major categories of disease but do nothing about the rate of aging, the average survival increases and the survival curve rotates about the fixed 110 year point. We are then dealing with what may be called a curve-squaring technology. That is what is happening today. We are headed towards the "theoretical" limits curve of Figure 1. Neglecting

the possibility of an actual retardation of the basic aging process, we can project as a "worst case" a society top heavy in its chronologically and functionally old population.

In an illuminating article in the June 1978 issue of SCIENCE, Drs. G. B. Gori and B. I. Richter examined the economic effects on society of preventing the major current causes of death, namely cardiovascular diseases, cancer, respiratory diseases, and diabetes. They seek to predict the economic impact of further disease prevention compared to the situation expected if current mortality rates remain unchanged. They write, "Initially prevention can be expected to prolong life in the productive age groups, but with time the lives saved will accumulate in older brackets, aggravating the aging of the U.S. population projected by the current census and augmenting the consequent socioeconomic complications that some experts forecast." The economic side effects of success in further prevention of age-related major diseases, i.e., of a purely curve-squaring technology, are unfortunately rather gloomy. If today's major killer diseases are largely prevented, resulting in an average life span to about 85, by the year 1995 we shall see, according to formal economic analysis, a 5% drop in the expected gross national product, a 3% drop in private housing starts, a 126% increase in unemployment over the expected figure, a ~~150~~ 157% increase in unemployment insurance benefits, and an increase in the social security tax to over 13% (Gori and Richter, 1978). I may add that Peter Drucker, the dean of management consultants in the U.S., agrees in principle with this prediction (Drucker, 1980). Notice the dilemma imposed by the situation of a purely curve-squaring technology.

We can hardly draw back from the goal of conquering cancer, heart disease, stroke, and such maladies. However, the conquest will impose an unfavorable economic potential upon our social structure.

What about a span-extending technology, in which the rate of aging is retarded and people live to be well over 110 years of age? How would that effect society?

Before tackling that question, let us inquire, what is in fact the possibility that gerontology will achieve a significant extension of maximum life span within the next 10 to 20 years? Let me first say that experts most often tend to underpredict the rate of advance in their specialties. In his recent book "The Physicists", C. P. Snow informs us that in 1933 Einstein, Nils Bohr and Lord Rutherford - the 3 greatest physicists of the first half of this century - all stated that we would never achieve power from the atom. Only 12 years later the bomb went off and proved them wrong. In the early 1950's experts in the new field of computing machines predicted that by 1970 there would be at least 100 sizeable computers in the United States. In fact, by 1970 there were 200,000. Of course one can cite cases in the other direction. So it's a difficult business. Nevertheless I am quite optimistic about the chances of retarding the rate of aging within the next 10 or 20 years, for the following reasons:

(1) Today we are not only in the Information Revolution but the Biological Revolution. Today in science is the age of biology just as the first half of the century was the age of physics. The rate of advance at all levels of biology is extremely rapid.

(2) Mankind has three classic dreams: going to the moon and other planets; the transmutation of elements (such as lead into gold, the alchemist dream); and the extension of maximum life span, so that people

live to enormous ages. Note that of these three classic dreams the first two have been to some extent achieved during our life times. I do not therefore have trouble believing that the 3rd might also be achieved during the span of lives now being lived.

(3) It is very likely possible right now, by fairly stringent measures, to increase maximun human life span to well beyond 120 years, so the question as to whether it is biologically possible to extend maximum life span has already been answered. It is possible. This extension can be achieved by a dietary program which one can label by the catch phrase "undernutrition without malnutrition." Such nutritional modulation of maximum life span has been amply demonstrated in numerous animal studies going back over the past 20 or more years. Since it is thus possible to extend maximum life span even today, the real question is, when will the methodology become simple enough to exert a general population impact? Other, potentially simpler methodologies for extending maximum life span include administration of antioxidants, finding out how to increase DNA repair rates, immuno-stimulation, hormonal therapy such as the use of thymic hormones, and neutralisation of the postulated DBCO hormone, the regulation of neutrotransmitter chemicals, as well as other therapies. I have discussed these elsewhere in some detail (Walford, 1983).

Let us assume therefore that extension of maximum life span is a real possibility in the not too distant future. What will be the economic effects on society of a span-extending technology? To begin thinking about such a question, we must realise that in a long-living society an increasing distinction will be made between "functional age" and "chronologic age." If the aging rate is retarded, a chronologically 90 year old individual may be functionally (in appearances, intellectual function, and athletic prowess the same as a 50 to 60 year old person of today. A span-

extending technology creates quite a different "functional age" society than a curve-squaring technology. By increasing maximum life span in this manner we are not just adding old years to old, but are stretching out the periods of youth and middle age.

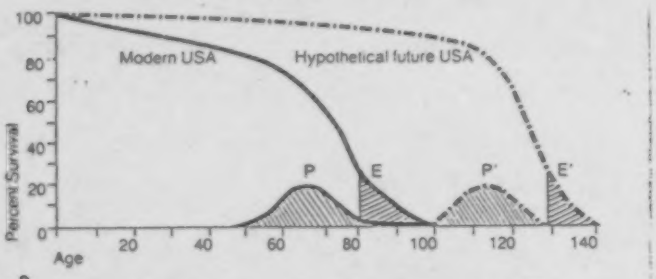

Fig. 2
Effect of extension of maximum life span in modern USA and in a hypothetical future USA on the frequency at different ages of the major diseases of aging (P and P') and on the occurrence of feeble or senile oldsters (E and E') in the population.

Figure 2 illustrates some of the effects of such life span extension. These are clearly seen in dietarily restricted animals, and would be seen in a long-living human society. Forst of all, the age-related diseases, such as cancer, heart disease, stroke and diabetes, will still appear in a long-living society; but as they are to a great degree secondary to the aging process itself, their time of onset will be postponed. In a 140 year-living society the age at which you get your heart attack will not be 65 as today, but 120. By substantial postponement, a span-extending technology in effect "cures" the major diseases for their present specific time periods.

Secondly, if we assume that the terminal portion of the survival curves shown in Figure 2 represent the time of greatest debility and senility in a population, we see that there will still be the same absolute number of debilitated senile persons in the long-living population, but the percentage of the total population which they represent will actually be decreased.

Retardation of the rate of aging thus gives us a chronologically older but functionally younger society than we have today - or that we are galloping towards by merely curing diseases.

What are the projected economic effects of a span-extending technology? The only formal published analysis of this important question is that of Professor Lawrence Kotlikoff of Yale University. His analysis was highly positive, concluding that population growth resulting from maximum life span extension will lead to an increase in the ratio of productive to nonproductive persons, an increase in per capita output regardless of whether the working period increased year for year with life extension or only proportionately, and an increase in "average consumption per year" as a measure of economic wealth. The span-extending technologies have strongly positive and curve-squaring ones negative potential for the future economic welfare of society.

My expectation on the basis of the above analysis is that, in relation to the age-structure of society the overall economic position will first of all worsen as further diseases are cured and the <u>average</u> life span shifts up towards the 85 year limit on a curve-squaring situation. However, as maximum life span is increased, the result of a span-extending technology, the picture will rapidly shift in a positive direction. The end result of advances in gerontologic research is therefore highly favorable for society. But if we merely cure diseases without retarding the aging rate, we are in for trouble because we shall be creating a society top-heavy in functional age. The National Foundation of Infantile Paralysis faced an interesting decision in the 1940-50s. It could have invested all its resources in better iron lungs. If that had been the case, we would today have the best and most

comfortable iron lungs imaginable ... in habited by thousands of polio victims. Instead of iron lungs, the Foundation invested heavily in basic research on the conquest of polio. That was certainly the wiser decision. Old age homes and the vast social support structures accumulating to care for the helpless aged - which by curing more and more diseases we are creating in more abundant quantity - are the iron lungs of gerontology. Further improvements in the support systems for the increasing functional elderly will merely provide symptomatic relief for an expanding problem. Retarding the rate of aging by gerontological methods will diminish the size of the problem.

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Senator CHAFEE. Well, Doctor, that is extremely interesting. How do you respond to the fact that thousands of Americans now have a life expectancy of 80, say, and cannot wait to quit their jobs at 62 and go some place like Sun City and have their life revolve around playing golf every day? This example opposes what you predicted here and might be a Utopian or overly optimistic presentation. What do you say to what is happening today?

Dr. WALFORD. The increase in average lifespan will produce almost a social revolution in many aspects. We are talking about people that are chronologically old but functionally young. I think they will not be retiring and going to Sun City. They will be having multiple careers, two or three or four careers if they are living to be 140 to 150. It will produce vast social changes.

For example, after a 30-year career, people will be reeducated to go on to a next career. There will be 5 years of retirement.

Senator CHAFEE. Why do you say it is not happening now in these lower ranges? In other words, the life expectancy has been dramatically increased since 1900, as all the charts have shown here, and yet just since the social security program has been in existance, it has increased dramatically. Nevertheless thousands and thousands of Americans, a discouragingly large number, just cannot wait to drop their tools and head for Florida, and with no idea of a second career of any kind, despite the fact that they are fit, and vigorous, and they have a life expectancy of many years.

Dr. WALFORD. Many people are in fact having a second career. Second, society discouages to some extent second careers for people who are not fairly gifted and economically secure. Many of the people who are retiring, as you say, are nevertheless functionally older.

Senator CHAFEE. Except that is the point. I do not think they are functionally older. I think they are fit.

Dr. WALFORD. Well, they are 55 or 60, but I am saying they will be functionally 40, and people that are functionally 40 are not retiring and going to Sun City.

Senator CHAFEE. Yes, Doctor Keyfitz?

Mr. KEYFITZ. May I make a comment on your last point?

Senator CHAFEE. Dr. Keyfitz is a man with a second career; he left Harvard and is now at the University of Ohio State?

Mr. KEYFITZ. I was not thinking of myself, sir. But the fact is that many of the discouraged people you speak of are so because they are in an occupation that has become obsolete. They are newspaper compositors, for example, or tool and die makers, and they are displaced by computers.

And the number of such, with the process of technical change, is going to increase. There is a possibility of an imaginative use of the social security plan in regard to that.

Now, what would be wrong with allowing people to take 2 years of social security for retraining at the age of 45? They would have to pay for that by deferring, let us say by 3 years, the actuarial equivalent, their retirement. Meanwhile, they would have 2 years in which to upgrade themselves, in which to take a brand-new occupation and start essentially a new life.

Senator CHAFEE. Well, that is a very original thought. I tell you, I just do not like to get too far abroad into other aspects here of

income and so forth. We are dealing, really, with lifespan and life expectancy.

Any other points that you gentlemen would like to make?

[No response.]

Senator CHAFEE. Dr. Manton, how do Crimmins three alternatives fit into the present projections for social security as you know them?

Mr. MANTON. Crimmins produced one set of projections for men and for women based on extrapolating the 1968 to 1977 data. Social security however produces three alternative projections for men and women. The Crimmins forecasts were "what-if" experiments. That is, they reflect what would occur if we take what had happened recently and extrapolate it to determine if we might again underestimate life expectancy changes.

The range of possible variability in the social security assumptions apparently capture what Crimmins has projected for males, but not for females. This is important because we know that there would be many more females at later ages. They have experienced a much greater increase in survival. So the net impact on social security potentially could be great.

Using currently observed data and putting aside broader speculations about potential lifespan extension, we need to determine if we should modify the process or procedures by which we model the life expectancy forecasts to take into account some of the observations that we are making?

Senator CHAFEE. Let me ask you each a question before we conclude here. Are you concerned over the present social security predictions, whether you consider their optimistic or their pessimistic or their intermediate ones? Do you share the concern I have or do you think that they are basically in the ball park?

Mr. MANTON. I think the most recent projections that have been made are much better than the ones in the past, but I am not at all certain that they reflect the full potential for life expectancy increase. If the speculations about lifespan extension are correct, then over the next 100 years, we may have some rather dramatic problems associated with the increasing elderly population.

I believe that there is some considerable further potential for dealing with chronic diseases and I do not necessarily believe that disability is going to go up quite as rapidly. My thinking on this has been characterized as optimistic.

I think that the sum of the life expectancy increases has been achieved by some net improvement in health at specific ages. This is a point for a lot of scientific debate. The possibility that our estimate is too low—as it has been over the last 35 years—is something that worries me considerably. At the same time, if our projections are too high it simply has the net effect of producing a reserve within the social security system a fiscally conservative approach. What we seem to be getting now is the scientifically conservative approach, which produces academically "safe" estimates for life expectancy forecasts. Anyone would have trouble speculating about increases in life expectancy over 40 years, but the forecasts suggesting major changes in life expectancy cannot be ignored. They are possible, and we have generally tended to underestimate the impact of technology.

Senator CHAFEE. All right.

Dr. Keyfitz.

Mr. KEYFITZ. Well, I can only say that I do not think that the social security forecasts fail to take account of past variability. One can see to what extent mortality and fertility and migration have varied in the past and put that variation into the projection, supposing similar variation in the future.

We have nothing else to go on, and if you put that in you get rather a wider range than they have. And within that wider range, I recommend that one take for the official forecast not the middle point, but a point that represents a somewhat worse, from the viewpoint of the fund, condition.

Senator CHAFEE. Do you agree with Dr. Manton on that point?

Mr. KEYFITZ. Yes, I do.

Senator CHAFEE. Dr. Walford?

Dr. WALFORD. I agree with what the gentlemen have said. I would like to make another point a little bit, Senator, with regard to whether people will retire at 60. I think you are projecting from the present and the past in the same manner that you have chided the statisticians for projecting from the past, so I don't think we can do that, predict what people will do with an extended lifespan. It is a fallacy to think that that will happen.

Senator CHAFEE. Well, maybe so. All I am pointing to is the fact that traditionally, I suppose, the time to retire was 65. Bismarck set it, I guess, and yet, with the increased life expectancy people seek the earlier retirement, whether they are UAW workers or those under social security.

As I say, as we sit here and go through these hearings, a whole series of hearings, it just seems that people cannot wait to leave that shop. And it is not just those whose skills are obsolete. It is those whose skills are perfectly needed, but they just want to head off.

And even though we have made changes in the law, as you know, which would permit people to keep their jobs so that they cannot be retired before the age of 70, very, very few choose to stay on. Academia is probably the exception. But most other places, they are not interested in 70, they are not interested in 75; 62 has become the key.

Yes, doctor?

Mr. KEYFITZ. Sir, you will admit that the community can only afford to have a certain fraction of its members in retired status. Somebody has to be there working. Now, it seems to me that this advance, this improvement in mortality that we are all talking about, should really be taken into account by having an automatic indexing, you can call it, according to expectation of life.

Suppose that the drafters of the original social security legislation had had the foresight to designate as the normal retiring age, not 65, but the expectation of life minus 12. That would have been 65 at that time. So it would have made no difference to any one then.

But counting from the end of life, not from the beginning, and taking the expectancy of life minus 12, today social security would automatically start at 67 years. Such an indexing by life expecta-

tion would solve many problems, would be having the difficulties and discussion we are now having.

Senator CHAFEE. Well, that is one of those things perhaps they should have done. I do not think you find many people in Congress who are prepared to advance that now.

OK, thank you all very much for coming. We appreciate it.

Dr. Walford, the point you were making here about the increase of the lifespan is achieved, as I understand it, by eating less, is that it? Eating right and eating less?

Dr. WALFORD. Yes, that is correct.

Senator CHAFEE. OK, fine. Thank you.

Let us go to the final panel, Dr. Hickman and Jim Hacking. All right, Dr. Hickman, why do you not go to it.

STATEMENT OF JAMES C. HICKMAN, PH. D., PROFESSOR OF BUSINESS AND STATISTICS, UNIVERSITY OF WISCONSIN, MADISON, WIS., ON BEHALF OF THE AMERICAN ACADEMY OF ACTUARIES

Mr. HICKMAN. Good morning, Senator Chafee.

First of all, let me say congratulations to the Senate Finance Committee for taking this long-term view.

I am a professor of business and statistics at the University of Wisconsin, and in order to save time and in part to keep me on the point, I think I will put some of my points up here on the overhead. This is mainly to make sure that I do not deviate.

It is difficult, when you come on late, to have anything new to say. My big points are, of course, what you already know.

Yes, it is a fact, life expectancies in the United States have increased significantly in recent years;

Second, the continuation of these trends will have a profound impact on the nature of U.S. society. It will be felt in insurance programs—I am here as a representative of the American Academy of Actuaries—and the areas of jurisdiction of this committee.

I also agree with Frank Bayo that these increases in life expectancies will be felt slowly and adaptations can be made. This is not like a war, epidemic, a natural disaster, or a recession. We do have some time to make adaptations. People do not live longer fast; they live longer slowly.

Now, these numbers in many ways duplicate what you have already seen, and they simply make the point that life expectancies have gone up, but they have not gone up uniformly either across time, between the sexes, or among the races.

That delta on the transparency is fancy language for the change. In the last 40 years for white females at birth, their life expectancy went up almost 11 years. At age 65, it only went up about 5 years. You notice those black numbers that I sketched in about the increase in life expectancies of white males—significant, but not as great as for females.

Senator CHAFEE. The first is from birth, the second one is from——

Mr. HICKMAN. From age 40, and the third one is from age 65. So that this is 65 over here, Senator, the bottom row of each of these tables.

So the point is that this increase has not been uniform across our population. Women have done better than men. Blacks and other nonwhite racial groups have done, in improvement terms, better than the whites. And it has not been uniform across time. The increase in some of these decades has been much less than the increase in others.

Now, here is a different way of looking at the same thing, and this is what Frank Bayo was talking about a little earlier. These are rates of decrease in overall death rate in different time periods and different age groups.

Now, by far the most graphic thing you see here is this number right there, the fact that in the last decade the rate of decrease in males above 65, after bumping along actually at a negative number in the previous 15 years, suddenly jumped up. Take a look at women. They have experienced the same kind of marked increase in the rate of decrease in this last 10-year period.

You have already seen facts like this, but the point is that these decreases in mortality have been important, but they have not been uniform either across time or within various groups.

Now let us look at the same kind of thing a little bit differently, from different sources. What I am going to talk about here is rates of decrease, and in those first two columns you will see rates of decrease in mortality for men, taken from the U.S. population. Notice that the rate of decrease has gone up between the midsixties to the midseventies, and then over the decade of the seventies that annual rate of decrease has gone up.

Here is some new data that we did not used to have, from the U.S. medicare. Notice that those numbers are roughly in the same magnitude. That is a different population. And since I am here representing the actuarial profession, the last column are numbers generated from the intercompany study of insured lives done by the Society of Actuaries.

The important picture here is that those numbers are not all that far apart when you look at roughly the same time period—as a matter of fact, they are quite close together—and that all of them disclose significant increases in the rate of decrease in mortality here in the last 15 years.

In the handout that you have there is a little bit more detail on this table. With respect to women you see the same kind of picture, the rate of decrease in mortality, has itself increased. But you also see a rough parallelism between the numbers generated by the Federal statistical agencies and those generated by studying private mortality patterns.

Now, to reinforce that point that I made at first yet another way, I am going to use a picture almost identical to one that you saw a few moments ago, and I am not going to make many different points.

Senator CHAFEE. Could you hold for 1 minute?

[Pause.]

All right, Mr. Hickman. Thank you very much.

Mr. HICKMAN. Thank you, Senator Chafee. As a teacher, I am used to having people walk out, but often they do not come back. Thank you very much.

This is the same table that you saw before. I will not dwell on it. I only want to make the point that without life expanding—now, remember, life expanding would push these curves out that way—projections, involving making the curve into a square, are bounded. There is only so much room for change, and so the question as to whether these life-expanding scientific breakthroughs will occur becomes quite important.

If in fact, like the "Deacon's One-Horse Shay," we are bounded by a particular time, the room for disagreements in projections is limited. If you, on the other hand, assume that we may be able to push the whole survival curve out, the business of projections becomes much more complicated and also the social implications become much different.

Now, I would like to turn to some of the possible implications of all of this. First of all, I want to stress that I am not an expert in genetics or biochemistry and therefore I cannot attach, with much confidence, a particular probability to the occurrence of the kind of breakthroughs that were mentioned by the previous speaker.

The next thing I want to stress is to reinforce what Frank Bayo said: We do have time to make adaptations. For example, all you have to do is to read the Wall Street Journal to understand how volatile our interest rates have been. The effects of those interest rates on the cost of life annuities, of the changes we have had in relatively recent weeks, are equal to or greater than rather marked changes in mortality projections.

Therefore, we have plenty of time to adapt to changing life expectancies relative to the volatility of other factors that also influence the cost of old-age pension systems.

Senator CHAFEE. Let me see if I understand. What you are saying is that in your business, you being with the insurance actuaries, that there are other factors that affect the insurance industry far more rapidly and significantly than a change in the life expectancy, namely interest rates for example?

Mr. HICKMAN. That is correct, sir. For example, a change in 2 percent in the interest rate has roughly the same effect on the cost of a life annuity as going from an unprojected table to one that has fairly heavy projections in it.

This fact is introduced to reinforce my point that we do have time for adaptation here in our public policy and our private policy. Some of the things that hit us, hit us without that lead time for adaptation.

Now——

Senator CHAFEE. How much longer will you be?

Mr. HICKMAN. I would like to speculate with you for just a moment. First of all, it seems to me inevitable, with what the statistics that have been presented to you, that the distribution of retirement ages will be moved upward. The cost of public income continuation programs, either public or private, would advance remarkably unless we do this.

You on the Senate Finance Committee, as you have mentioned, have already sent a signal and made a major adaptation. You have other tools at your command: the age at which tax-sheltered savings can be withdrawn, the age at which double income deductions go into effect, the upper age on mandatory retirement. That is just

a small list of the tools available to the Congress to facilitate the gradual moving upward of the distribution of retirement ages, and I do use the word "gradual."

Remember also that health care expenditures have been a source of concern to this committee and to the rest of the Nation. We have seen an increasing share of our GNP go to health care, and you haven't seen anything yet. Given any kind of lengthening that we are seeing, these problems will become more difficult, not less difficult, as we have more consumers of health services.

It is true that how difficult these health care cost problems will become depends in part on which model will be realized for mortality improvement, the squaring the survival curve model or the push-it-outward model, as the last speaker indicated.

Third, a lot of our existing social institutions are going to be strained. With that lower mortality of women as well as the lengthening lifetime of everyone, we have already got a problem of a lot of older single women. We are going to have a lot more.

We have got the existing problems of providing income and health care. We are going to have an increasing number of social problems, because at least in my view it is not good to have no interchange among the age groups. My guess is we are going to spend more on education, both for the retraining that Professor Keyfitz mentioned, but also simply to provide another medium to keep our society together.

Finally, on the Federal statistical agencies, their value to those of us that work more in the private sector is increasing, rather than decreasing. For a lot of cost and other reasons, the data that is generated on mortality in the private sector is probably not as extensive as it was once. Our dependence upon the independence and competence of those Federal statistical agencies is increasing, not decreasing. In a society like ours, we need to know where we are going if we are to get to the right place, and their independence and their competence is very important to us.

Those are my main points, Senator Chafee.

[The prepared statement of James C. Hickman follows:]

AMERICAN ACADEMY OF ACTUARIES

STATEMENT OF DR. JAMES C. HICKMAN
ON BEHALF OF THE AMERICAN ACADEMY OF ACTUARIES
TO THE SENATE COMMITTEE ON FINANCE,
SUBCOMMITTEE ON SAVINGS, PENSIONS, AND INVESTMENT POLICY
JULY 15, 1983

Trends in Life Expectancy and the Implications of These Trends

1. Introduction

My name is James C. Hickman. I am a Professor of Business and Statistics, University of Wisconsin, Madison. This morning I am responding to your invitation to the American Academy of Actuaries ("Academy") to provide testimony on the topic of today's hearings.

The Academy is an organization with approximately 7,200 members, most of whom are engaged in the practice of actuarial science in the United States. Academy membership includes actuaries in all areas of specialization and types of employment. Actuarial science is the science of developing mathematical models for use in designing and managing financial security systems. These systems include all types of private insurance, pensions and other employee benefit plans, and social insurance, all of which will be affected by the trends under consideration today.

I am a member of the American Academy of Actuaries, a Fellow of the Society of Actuaries, and an Associate of the Casualty Actuarial Society (the latter two organizations being founding organizations of the Academy). In my teaching and research as well as in my consulting work (which included service to the Senate Committee on Finance in 1975-76 as a

1835 K STREET, N.W. SUITE 515 WASHINGTON, D.C. 20006 (202) 223-8196

Member of the Consultants Panel on Social Security), I have been a student of the subject of today's hearing.

2. Summary

The major points that I want to make are:

A. Life expectancies in the United States have increased significantly in recent years.

B. A continuation of these trends will have a profound impact on the nature of United States society. This impact will be felt in insurance and pension programs and the areas of jurisdiction of this Subcommittee.

C. The impact of increases in life expectancies will be felt slowly and adaptations can be made.

3. Facts

To establish the fact that life expectancies have increased, I have inserted Table 1 which displays life expectancies for various groups within the United States under the assumption that the mortality experienced in the indicated year would continue throughout the lifetimes of members of each classification group.

From this abbreviated table the following conclusions can be made:

A. In general, life expectancies have increased in the United States.

B. The amount of the increase has not been uniform among population groups or across time.

(i) Until recently, there were relatively small increases in life expectancies for those aged 65 and over.

(ii) Increases in life expectancies have been greater for women than for men, and greater for blacks and others than whites.

Table 1
Life Expectations in Terms of Remaining Years
U.S. Population

Female - White

Age	1939-41	1949-51	1954-61 (1959)	1969-71	1979
0	67.3	72.0	74.2	75.5	78.2
40	33.3	35.6	37.1	38.1	40.2
65	13.6	15.0	15.9	16.9	18.7

Male - White

				(69.9)	
0	62.8	66.3	67.6	75.6	70.6
40	30.0	31.2	31.7	31.9	33.9
65	12.1	12.8	13.0	13.0	14.2

Female - Black and Other

0	55.5	62.7	66.5	69.1	74.2
40	27.3	29.8	32.2	33.9	37.6
65	14.0	14.5	15.1	16.0	18.4

Male - Black and Other

0	52.3	58.9	61.5	61.0	65.5
40	25.2	27.3	28.7	28.3	30.9
65	12.2	12.8	12.8	12.9	14.4

Source: Statistical Abstract of the United States, 1982-83. Table No. 106.

Table 2 provides another way for summarizing changes in U.S. mortality. It shows average annual declines in the National Center of Health Statistics age-adjusted death rates (using the 1970 U.S. population as a standard), for the whole population and the population aged 65 and over, for selected periods in the twentieth century.

Table 2

AVERAGE ANNUAL DECLINES IN NCHS AGE-ADJUSTED CENTRAL DEATH RATES FOR AGES 65 AND OVER AND FOR ALL AGES DURING SELECTED PERIODS, BY SEX*

Period†	Male			Female		
	Ages 65 and Over	All Ages	Ratio	Ages 65 and Over	All Ages	Ratio
1900–1936	0.16%	0.87%	0.18	0.30%	1.02%	0.29
1936–54	1.16	1.67	0.69	1.88	2.65	0.71
1954–68	−0.30	−0.14	.....	0.75	0.77	0.98
1968–77	1.55	1.83	0.84	2.38	2.35	1.01
1900–1977	0.47	0.99	0.48	1.00	1.52	0.66

*Age-adjusted central death rates were calculated by the direct method, using the enumerated population of the United States on April 1, 1970, as the standard, and using age-specific central death rates based on the most recent population estimates for each year.

†Periods were selected because of discernible changes in trend.

Source: J.C. Wilkin, "Recent Trends in the Mortality of the Aged," Transactions, Society of Actuaries, Vol. 33 (1981), p. 11-44.

The conclusions from Table 2 are much the same as from Table 1. Decreases in death rates have occurred throughout this century but not at uniform rates. One of the most singular features of these data is the increase in the rate of mortality decrease in those aged 65 and over since 1968.

Table 3 provides more detail on the rates of mortality decrease in recent years. The increased rate of decline between 1971-76 and 1977-79 compared with 1961-65 to 1971-76 stands out. The column titled, "Inter-Company Insured Lives 1970-75 to 1976-79" reports on mortality experience collected by the Society of Actuaries.

Table 3

Comparison of Annual Improvement Rates

Age	U.S. White Population 1961-65 to 1971-76	U.S. White Population 1971-76 to 1977-79	U.S. Medicare 1973 to 1977	Intercompany Insured Lives 1970-75 to 1976-79
		Males		
7		2.05%		-
12				3.17%
17		-0.39		-0.02
22				0.85
27		0.86		1.20
32				2.00
37		1.32		3.15
42				4.28
47		2.66		3.69
52	0.77%		2.40%	3.34
57	0.74	3.24	2.23	4.61
62	0.41	2.21	1.97	2.85
67	0.72	2.41	2.75	3.54
72	0.88	2.14	2.15	2.07
77	-0.19	1.97	2.15	3.35
82	0.44	1.12	1.59	1.81
87	0.11	2.17		2.42
92				-0.05
97				
		Females		
7		3.24%		-
12				2.44%
17		0.78		-1.68
22				0.77
27		2.72		4.58
32				3.07
37		4.10		2.40
42				2.77
47		2.16		1.80
52	0.43%		2.39%	3.47
57	0.20	2.22	3.44	3.58
62	0.58	1.15	3.78	0.07
67	1.53	1.83	3.53	2.59
72	1.30	2.67	3.54	3.66
77	1.01	2.45	2.71	3 74
82	1.73	1.99	1.02	2.80
87	2.15	2.85		4.97
92				-0.23
97				

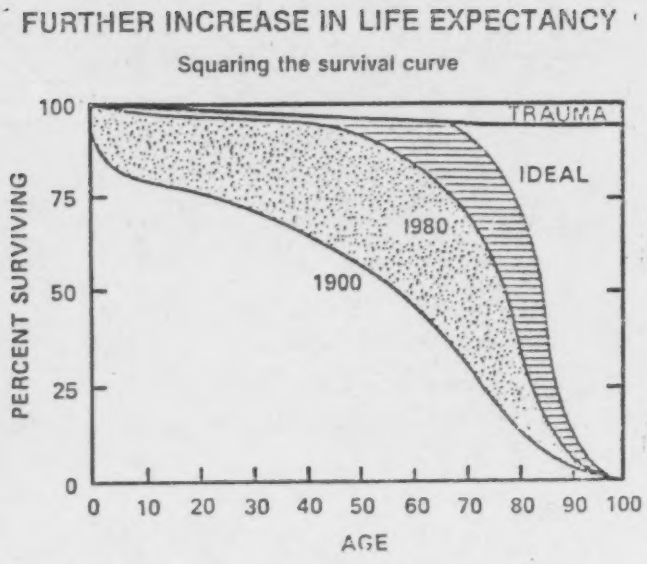
Source: "Report of the Committee to Recommend a New Mortality Basis for Individual Annuity Valuation," Transactions, Society of Actuaries, Vol. 33 (1981), p. 675-735.

4. Models of the Future

It is clear that mortality rates have declined and life expectancies have increased. What has caused these changes and is identifying the cause of any importance? From a study of cause of death statistics, it appears as if much of the overall decline in mortality rates is associated with a decline in mortality from cardio-vascular diseases. The natural question about this welcome decline is whether it is due to the treatment of hypertension, improved diet, reduced smoking, or good luck. Probably each of these factors has had an effect but it is difficult to order them by their importance.

The second question is whether identifying the causes of recent changes is of any importance? The answer is that if we are to make sensible models of the future, it is helpful to understand the past.

Two basic models of human mortality change, plus many variations, are in common use. One model might be said to involve "squaring the survival curve." This model is depicted in Figure 1. It displays past survival patterns and provides a framework for modeling the future. This model is built on the assumption that there is a more or less fixed upper band on human survival and that mortality changes have the effect of "squaring the survival curve." In other words, humans will increasingly become like Oliver Wendell Holmes, "The Deacon's Wonderful One Horse Shay." There is evidence that most of the mortality change in this century has had the effect of "squaring the survival curve." Life expectancies have increased, but various measures of the variability of the age of death have decreased. We live in a more certain world, as far as mortality is concerned, than our grandparents.



Source: JAMES F. FRIES, M.D., THE NEW ENGLAND JOURNAL OF MEDICINE, JULY 17, 1980.

Figure 1

The second basic model is that future mortality change will push the survival curve to the right with few dramatic changes in the shape of the curve. Some very recent studies of human mortality above age 90 have added credibility to this model.

The implications for society of increased life expectancies will depend, in part, on which of these models proves closer to reality.

5. Technical Issues

A survival curve, as pictured in Figure 1, is a simplified model for describing human mortality and a tool for projecting future survival patterns. However, as is true for most simple models, it can conceal important facts. An alternative model is a survival surface. A survival surface provides values of $l(x,u)$, the expected number living at age x out of those born during calendar time u. Thus by holding u fixed, one can study the survival of a cohort of lives all born at the same time. Alternatively, by fixing the time of observation at, say, 1983, one can study $l(x,1983-x)$, the expected number of survivors to age x of those born in $1983-x$. This second type of study would involve a "snapshot" look at survival in 1983. Both types of studies can be useful and both can be used to produce survival projections.

Within insurance and pension plans, interest centers not on survival time from birth but on entry into the insurance or pension system. Survival studies that are based on lives after entry into such a system are called "select" studies and are very important in actuarial science.

In such studies the actuary is concerned with $l([x]+t)$, the expected number surviving to time t measured from entry into the insurance or pension system at age [x]. The Society of Actuaries' mortality studies of insured lives examines survival for 15 years following selection at the time of entering into an insurance system. The effect of insurance selection probably never completely wears off, however after 15 years the practical effect of selection is greatly reduced. Select studies are important for detecting shifts in selection standards but they do not duplicate the population cohort studies done by federal statistical agencies.

One can detect periodic influenza epidemics in insurance survival studies. However, these periodic increases in mortality are not that important in insurance management. Typically the toll of these epidemics falls most heavily on groups that do not carry large amounts of individual insurance. In addition, individual insurance has a price-benefit structure that does not permit the structure to alter to accommodate periodic relatively small increases in mortality.

6. Implications

The impact of lengthening life expectancies will not hit in a short period. Epidemics, wars, recessions, and natural disasters require an immediate response. Because people live longer slowly there is time for orderly adaptations. This does not mean that the changes can be ignored, only that the response can be a measured one.

It is fortunate that this is so. As illustrated in Tables 1, 2 and 3 the rate of mortality improvement in the past has not been uniform and it is not likely to be uniform in the future. It is necessary that we study the trends affecting our society and plan appropriate responses, but it is naive to believe that we can establish any long term system and expect it to run without modification.

Actuaries are not specialists in genetics or biochemistry. Therefore, I cannot attach, with much confidence, a probability to the event of a scientific breakthrough which would have a discontinuous impact on human life expectancies. Such an event may occur, and we must keep our business and government systems flexible enough so that adaptation will be possible. However, we should not behave as if such an event is certain.

Table 4 is designed to illustrate the relatively modest impact on the expected present value of a life income of one dollar per year assuming 7% or 9% annual interest and the mortality experienced by annuitants in 1983 or on a projected basis. The projected basis assumes rates of annual mortality improvement. The improvement factors range from 1.5% per year at age 65 to 1% per year at age 97 for men and 1.75% per year at age 65 to 1.25% per year at age 97 for women. The point is that although continued mortality improvement makes a difference in life annuity values, the difference is not dramatic and interest rate changes, modest by comparison with recent variations, are of greater significance.

Table 4

Effect of Projecting Mortality

1983 Table G with Projection Scale G - Base Year 1983

		Unprojected Annuity $\ddot{a}_{x}$ (1)	Projected Annuity $\ddot{a}_{x}$ (2)	Ratio (2) ÷ (1) (3)
Male 65	7%	10.265	10.566	1.029
	9%	8.959	9.204	1.023
Male 75	7%	7.867	8.094	1.029
	9%	7.130	7.301	1.024
Male 85	7%	5.450	5.566	1.022
	9%	5.097	5.193	1.019
Female 65	7%	11.246	11.589	1.030
	9%	9.734	9.958	1.023
Female 75	7%	8.868	9.149	1.032
	9%	7.948	8.155	1.026
Female 85	7%	6.041	6.192	1.025
	9%	5.615	5.738	1.022

Source: R.J. Johansen, Record, Society of Actuaries, Vol. 8 (1982), p. 1484.

Mortality changes and projections are frequent subjects of discussion at meetings of actuaries. This does not provide complete assurance that surprises are impossible to the managers of insurance and pension systems, but data are under almost continuous review.

7. Speculations and Adaptations

Now let us turn to speculations about the future if human life expectancies continue to increase. Along with our speculation let us record possible adaptations that society might make. Clearly lengthening life expectancies means that the number of persons over age 65 will increase and, if fertility rates remain low, the proportion of the population over age 65 will also increase.

A. Unless the distribution of retirement ages is moved upward, the cost of retirement income programs, both public and private, will advance. The natural adaptation, already a part of the 1983 amendments to the Social Security Act, is to increase the normal retirement age. Congress has other tools to encourage adaptation. Changing the age at which tax-sheltered savings can be withdrawn without tax penalty, the age of the double income tax deduction, and the upper age on mandatory retirement are examples of policy variables under the control of Congress.

B. Health care expenditures for the elderly will increase significantly. The size of these expenditures will be determined not only by the size of the population over age 65 but also by the way the health care system is organized, whether new technology will increase or decrease unit costs, and by the model that the mortality change follows. That is, if the "survival curve" is "squared" perhaps periods of illness before death will shorten. If the survival curve is simply pushed to the right, perhaps disability patterns

will not change. Rates of inflation in the health care sector have exceeded those in the general economy in recent years, leading to ever-increasing proportions of GNP being devoted to health care. The aging of the population will exert further upward pressures on health care costs and make this trend difficult to halt or reverse.

C. Existing social institutions will be strained. Because of the lower mortality of women, and their higher rate of mortality decrease, the prospect of an ever higher proportion of elderly single women is more than a speculation. Besides the existing problems of providing income and health care, the even more basic issue of how to keep this group integrated into society will increase. Greater social interaction among the ages must be encouraged through higher and more flexible retirement ages, and encouragement for volunteer activities. Life-long educational activities may become a tool for encouraging social interaction among age groups as well as a retraining tool to accommodate longer working lifetimes.

8. Federal Statistical Agencies

The federal statistical agencies (Census Bureau, National Center for Health Statistics, Social Security Administration) are the principal sources of the basic data on mortality and morbidity in the United States. The mortality and morbidity of insured lives may be studied by individual companies or the data from several companies may be gathered and analyzed collectively. Mortality and morbidity from specific illnesses may be studied by medical research centers. However, there are no other agencies that study the health status of the entire nation. Even for insurance and annuity purposes, the role of statistics collected by federal agencies is increasing.

Although actuaries may on occasion have technical arguments with members of the federal statistical agencies, I believe it is fair to say that actuaries in the private sector rely to a considerable extent on statistics collected by federal agencies in measuring the rate of mortality decrease. In a democracy we have the political mechanism for adapting to change. If these adaptations are to be successful they must be based on sound information. A high level of competence and independence of federal statisticians is necessary for our government system to work. In their work within both the private and public sectors, actuaries depend on mortality, morbidity and economic data collected by federal agencies. If the quality of these data declines, our vision of the future will become even more blurred.

9. Conclusion

Increases in human life expectancies have occurred in the past and will probably continue into the future. The impact of these changes will be slow but profound. The nation needs excellent statistical agencies to monitor these changes. The required adaptations by society need not be abrupt but may well involve alterations of public policy on retirement, taxes, and spending. People will need to be encourage to have a longer period of active employment. The aging of the population will increase the difficulty of finding solutions to the health care cost spiral.

Senator CHAFEE. Well, I certainly agree with the last point. Also, it seems to me that when you are discussing that, sure, there are other factors that significantly influence your industry such as interest rates. Yet still, you try and eliminate as many unknowns as you possibly can because you have got enough trouble with the unknown unknowns.

In the chart that you put up there, you indicated that there seems to be a great similarity between the three columns.

Mr. HICKMAN. Right.

Senator CHAFEE. But I did not find that similarity, and I have your testimony here you said the statistics were roughly the same. The one you had dealing with the annual improvement with just, say, the white male population.

Mr. HICKMAN. For the same time period.

Senator CHAFEE. Unless I missed something from your testimony—let us look on page 5 and work across. Let us take age 77. Let us take U.S. white population, males. There was 1.57 percent decrease, is that right?

Mr. HICKMAN. That was the annual rate of improvement in the period indicated, which was——

Senator CHAFEE. Now look at the last column, you inter-company insured lives. Your periods do not exactly correspond.

Mr. HICKMAN. That is one of the problems, Senator Chafee.

Senator CHAFEE. But the difference is so significant. It is nearly doubled, 3.35.

Am I missing something?

Mr. HICKMAN. No, you are correct. But I would also ask you, for example, although the comparison is not so graphic, if you went back to 72, another age, that actually the intercompany study comes in a tad below the two sources of Federal statistics. And I perhaps overemphasized the parallelism, but——

Senator CHAFEE. By the way, the one you pointed out I believe is the only one that is lower.

Mr. HICKMAN. You may well be right.

Senator CHAFEE. I suppose the difference is that the people who are getting insured are probably people of a higher income bracket, of a better educational level, of all of those significant factors that Dr. Manton and others pointed out that influence life expectancy.

Mr. HICKMAN. That is the reason why the price of private insurance is not directly based on Federal statistics. You are right, people that buy insurance are not a randomly selected subset of the population.

Senator CHAFEE. So I would not even expect your figures to be the same as the national.

Mr. HICKMAN. Indeed, I would be surprised if they were. And perhaps I think each of us come to this with a little different background. They are closer than I thought they would be. You came from a different background and you were struck that they were different. I thought there would not be even that degree of parallelism.

Senator CHAFEE. OK. Well, thank you.

Mr. Hacking.

STATEMENT OF JAMES M. HACKING, ASSISTANT LEGISLATIVE COUNSEL, AMERICAN ASSOCIATION OF RETIRED PERSONS, ACCOMPANIED BY LAURIE FIORI, LEGISLATIVE REPRESENTATIVE, AND MARTY CORRY, LEGISLATIVE REPRESENTATIVE

Mr. HACKING. Thank you, Mr. Chairman.

I am the assistant legislative counsel for the 14 million member American Association of Retired Persons. Let me introduce my colleagues. On my far right is Laurie Fiori. On my right is Marty Corry. They are both members of the AARP legislative staff and the ones responsible for producing the association's statement for the hearing record.

Neither I nor any one of my colleagues is an actuary, but I think, like yourself, we have a very healthy appreciation for the consequences of what has been presented to the subcommittee today.

Regardless of whose life expectancy forecasts you believe, it is clear that the population is growing older. Experts may differ over the pace and degree of this trend, but not over the direction or the significance of the trend. Individuals, private organizations, and public entities must all share the responsibility for dealing with the consequences of that trend.

With respect to the Federal Government, we think it should seek to remove impediments to elderly self-sufficiency, such as in the labor markets and in the promotion of private savings, and provide essential services where self-help is not feasible, such as in the health care area.

Government policy ought to encourage and reward, rather than discourage and penalize, elderly labor force participation. Any share of the elderly's total income that could be generated with the elderly's own work effort represents a share that need not be borne by public transfer programs and the younger taxpayers who support them.

Clearly, additional work effort would benefit the elderly by providing them with a greater feeling of independence and improving their prospects for maintaining their living standards in their later years of life. Just as clearly, the Government would benefit from the gains in national income and tax collections that would result.

Despite the benefits associated with elderly labor force participation, workers have tended to retire at ever-earlier ages throughout the postwar period. Labor force participation rates for men age 65 and over, for example, have dropped from roughly 45 percent in 1950 to 17.6 percent in 1982.

This declining elderly labor force participation trend has occurred for a wide variety of reasons, including the elderly's own choice for greater leisure, the growth of Government income support programs, and the adequacy——

Senator CHAFEE. Are you on chart one now? By the way, what do you consider "elderly"? Do you use over 55? I notice your charts are based on——

Mr. HACKING. These charts were projections for subgroups 55 to 64, both male and female, and then 65 and over. We are not putting a specific definition on the word "elderly."

Senator CHAFEE. Now, let us take chart one. On the left-hand column one finds percentages, is that correct?

Mr. HACKING. Yes, that is correct.

Senator CHAFEE. So what you are saying is that—let us take 1950—eighty-seven percent of the men in this group 55 to 64 were in the working force.

Mr. HACKING. That is right.

Senator CHAFEE. But 1975, this issue decreased to about 75 percent.

Mr. HACKING. Yes, roughly.

Senator CHAFEE. The point you are making is the one I was making before, that people, regardless of longevity, want to quit earlier.

Mr. HACKING. Yes, that is right. If you look at chart three, you will see how much more aggravated that trend is among men age 65 and over. You see that in 1950 you had well in excess of 45 percent of males 65 and over in the labor force. Yet by 1975, you had just a little over 20 percent.

Senator CHAFEE. Well, those are very significant charts. I had a feeling that what I was saying simply from empirical evidence was correct. I did not however have the statistics that you have. I would be interested in finding out why you think this is happening. It seems to go against Dr. Walford's notion that as people will live longer they will take advantage of these second and third careers. And yet, the statistics do not bear it out, do they?

Mr. HACKING. Well, increasing longevity is one trend, but there are other trends. Early retirement is and has been a very significant trend, with very great implications for the economy and for our income support programs. Now, as for the reasons that explain the declining labor force participation trend, there are a lot of them.

For example, the elderly's own choice for greater leisure, the growth of Government support programs, the adequacy of those programs in terms of the benefits that they provide, institutional rigidities about retirement, adverse economic conditions, economic disincentives to work, discrimination against older workers, and a change in industrial structure affording fewer job opportunities for workers whose skills have become outdated as a result of technological change.

Now, in view of the trends, it should be apparent that Government policies which create incentives for premature labor force withdrawal on the part of older workers are imposing serious and unnecessary costs on the economic system and on our income support programs. These policies AARP feels must be changed.

In the context of social security, just looking at one area, AARP feels that the best response to the long-term financial consequences of these trends is to pursue an aggressive older worker promotion strategy that would include, among other things, a gradual phasing out of the earnings test for workers age 65 and over, an increase in the delayed retired increment to 8 percent, a steepening of the early retirement penalty at age 62, and the liberalization of the eligibility rules for DI in order to assure availability of benefits for those with chronic work-impairing conditions.

We still view this kind of a coordinated package of changes in social security as superior to simply raising the age for full benefits, as was done by the social security legislation earlier this year. We do not expect that raising the age for full benefits to 67 in the next century is going to change the early retirement trend, just because the incentives to retire early and the disincentives to continue to work beyond the age of 65 will continue to be quite strong.

While I am on the subject of work-promoting incentives, I do not want to neglect employers and the need to focus on them. AARP has long felt that the tax laws could be used to encourage employers to introduce a host of job training, retraining, part-time and flexitime programs that will be needed to stimulate employers' demands for the services of older workers.

To complement these and other components of the older worker employment strategy that our statement for the record describes in greater detail, I would also suggest the need for increased job opportunities under some of the Federal employment programs, such as the senior community services employment program of title V of the Older Americans Act.

Let me shift the focus just a bit, away from employment and to private pensions and savings. As a means for relieving future demographic pressure on Government income support programs, private pensions and personal savings we think should be promoted as much as possible as sources of income for the future elderly.

Advance funding of a portion of the cost of providing income for the future much larger elderly population will assure that the post-World War II baby boom population will have savings of their own and will be less dependent on pay-as-you-go transfer systems for retirement income.

Additionally, since advanced funding provides savings to finance investment, the private pension system and private savings in general are being looked upon increasingly as mechanisms for fostering economic growth. While our statement for the record makes a number of specific recommendations with respect to ERISA and the Age Discrimination in Employment Act, I shall not go into those here, but I do wish to indicate our support for the kinds of savings incentives that were part of the 1981 tax bill.

The response of individual taxpayers to those incentives to save——

Senator CHAFEE. Are you speaking of IRA's?

Mr. HACKING. IRA's and Keogh's, as well as changes with respect to private pension plans.

For the growing number of elderly persons whose life expectancy is increasing and among whom chronic disease is becoming the dominant pattern of illness, and with the trend toward smaller families portending less and less family care to elderly and impaired patients, the Federal Government must begin to develop a more rational and cost-effective framework for delivering long-term care services.

That framework we think should include roles for the individual, the family, as well as Federal and State government. Although there are many programs to help older persons remain in their communities, they tend to be fragmented and totally uncoordinated. Having been separately conceived, they are separately adminis-

tered with separate criteria for establishing eligibility and need for service.

Furthermore, when it comes to in-home services, community services, special living arrangements, nursing home care, and other forms of long-term care at the State or local level, there has been to date no serious comprehensive effort from the Federal level to encourage the coordination and delivery of these services within the community.

We think a great deal needs to be done in this area and the time to start is now.

Thank you.

[The prepared statement of Mr. Hacking follows:]

STATEMENT

of the

AMERICAN ASSOCIATION OF RETIRED PERSONS

before the

SENATE FINANCE SUBCOMMITTEE ON
SAVINGS, PENSIONS, and INVESTMENT POLICY

on

INCREASED LONGEVITY: PUBLIC POLICY IMPLICATIONS

JULY 15, 1983

I. INTRODUCTION

Thank you, Mr. Chairman, for giving AARP the opportunity to present its views on trends in life expectancy and their implications for retirement, social and economic policies. As an organization representing 14 million older persons, it is particularly refreshing to see this committee, which has such a full agenda, take time to step back from the immediate problem of budget and tax policy to look ahead to where we are going.

Regardless of whose life expectancy numbers you believe, it is clear that our population is growing older. Experts may differ over the pace and degree of this trend, but not that that trend is significant. Since 1960, over two years of life have been added to the life expectancy of the average 65 year old American. This trend is a real credit to our nation. But at the same time it poses significant challenges. For example, the fastest growing sub-group among the elderly are single elderly women 75 years of age and older -- many of them widows. This group has the highest poverty rate among the elderly and the highest rate of dependency on Social Security -- up to 85-95% of their total income.

The response to the trend toward an older population cannot rest with any single segment of society. Individuals, organizations, and public entities all must have a part to play. For example, through AARP, our members are provided with opportunities to enhance their health, better plan for their

financial needs and maintain an independent lifestyle. The federal government has a role to play also. It should seek to remove impediments to greater self-sufficiency, such as in the labor market, and provide essential services where self-help is not feasible, such as in the health care area.

The balance of our statement today will focus on some of the areas where the federal government can remove impediments and provide essential services. Whether by design or by default this country will have a policy toward increased longevity. We hope that this committee will continue to address this phenomenon so that it is the former and not the latter.

II. OLDER WORKER PROMOTION STRATEGY: LOGICAL RESPONSE TO INCREASING LONGEVITY

The emerging trend toward longer lifespans has generated concern over the degree of dependence which the elderly have on government income support programs. The recent debate over long term social security reform highlighted that concern. As the elderly begin to comprise a growing proportion of the population, a high degree of dependence on government support programs could pose a heavy burden on the younger worker population.

Given emerging demographic trends, government policies ought to permit and strongly encourage greater elderly labor force participation. Any share of the elderly's income that can be generated through their own work effort represents a share that need not be borne by public programs and the younger taxpayers who support them. Clearly, additional work opportunities benefit older individuals as well, raising their standard of living, providing them with a greater feeling of independence and self-determination and improving their prospects for maintaining their living standards in their later years. Just as clearly, the nation as a whole would benefit from the gains in national income and tax collections that would result from our getting the most from our previous investment in the training, education and experience embodied in older persons.

Elderly Labor Force Participation Trends

Despite the benefits that greater elderly work effort can yield, current work trends are ominous. Work and retirement patterns of the over age 55 population have altered dramatically since World War II as illustrated in the charts on the following pages. Labor force participation rates for men age 65+ have dropped from roughly 45% in 1950 to 17.6% in 1982. For men age 55 to 64, rates have dropped from 87% in 1950 to 70.7% in 1982. Thus, participation rates for men over 65 are now less than half their 1950 rates.

The trend toward early retirement is also clear. Work force levels in 1982 of men age 55-64 are 80% of their 1950 levels. In addition, a majority of workers claim social security benefits prior to age 65, a trend which not only adds to social security costs but to some extent deprives it of payroll tax revenue.

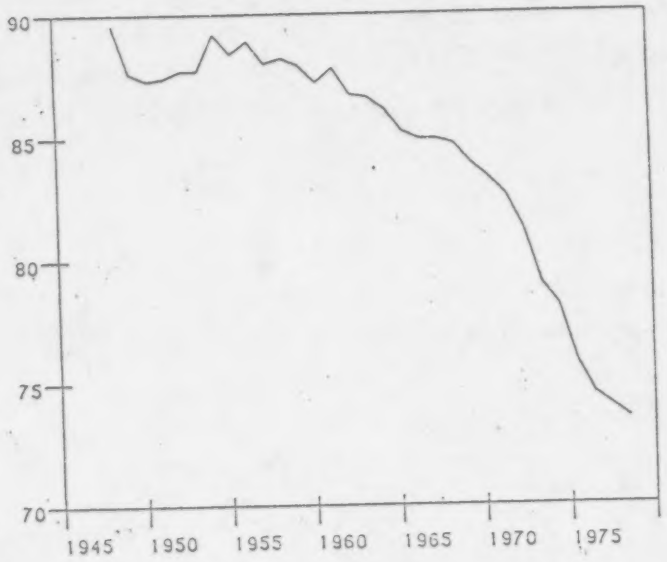
Work force participation for women differs from that for men. Women, ages 55-64, have increased their labor force participation, while the rates for those over 65 have been gradually declining since the late fifties. These rates have declined steadily over the period and the decline appears to have intensified in recent years.

25-513 O—83——11

CHART I

LABOR FORCE PARTICIPATION RATES

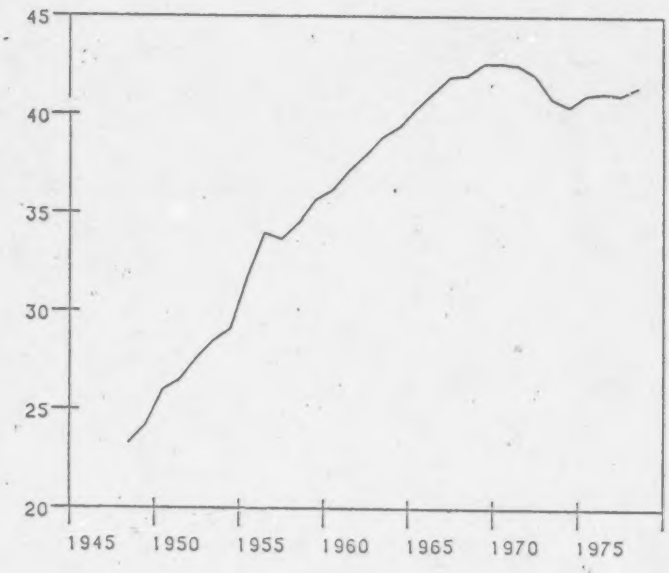
MEN 55-64



Source: Inflation and the Elderly - Part II, report prepared by Data Resources, Inc. for NRTA/AARP. January 1980

CHART II

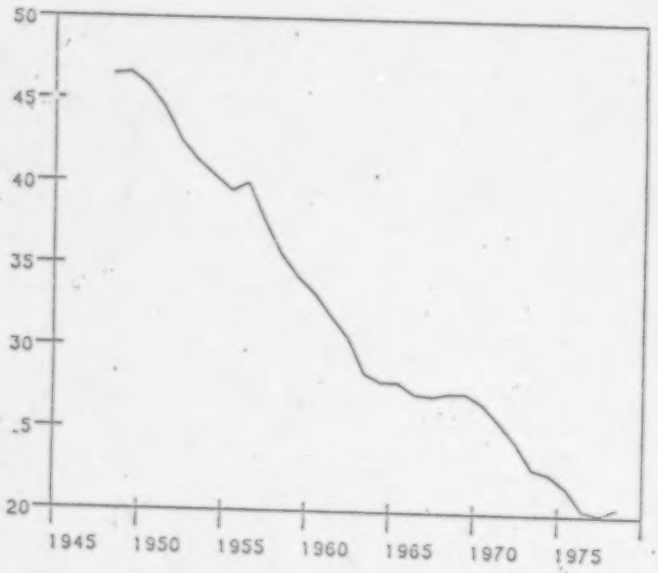
LABOR FORCE PARTICIPATION RATES
WOMEN 55-64



Source: Inflation and the Elderly - Part II, report prepared by Data Resources, Inc. for NRTA/AARP. January 1980

CHART III

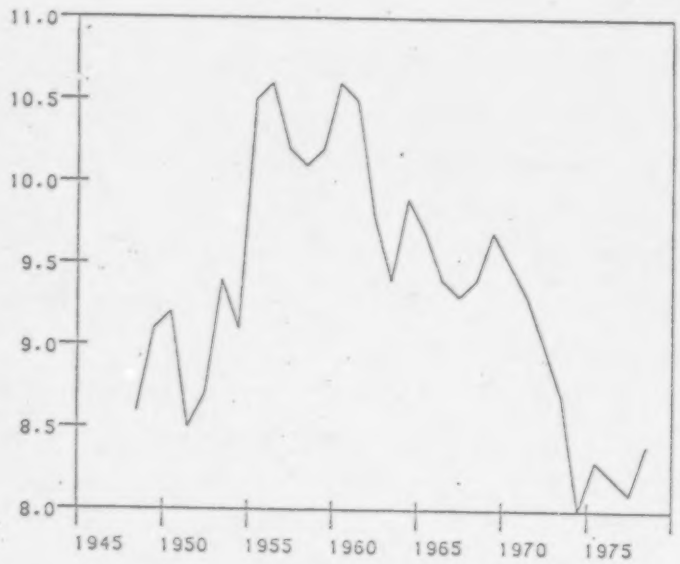
LABOR FORCE PARTICIPATION RATES
MEN 65 AND OVER



Source: Inflation and the Elderly - Part II, report prepared by Data Resources, Inc. for NRTA/AARP. January 1980

CHART IV

LABOR FORCE PARTICIPATION RATES
WOMEN 65 AND OVER



Source: Inflation and the Elderly - Part II, report prepared by Data Resources, Inc. for NRTA/AARP. January 1980

Fewer elderly participate in the labor force for a variety of reasons including their own choice for greater leisure, the growth of government income support programs, institutional rigidities about retirement, adverse economic conditions, discrimination against older workers and a changed industrial structure affording fewer job opportunities to older workers whose skills are outdated. Whatever its causes, less labor force participation translates into greater dependence on private savings and current income support programs. Moreover, once out of the labor force, studies indicate that the elderly are not likely to return.* Therefore, living costs must be met from existing income sources rather than new earnings opportunities.

Macroeconomic conditions play an important role in affecting retirement behavior. For example, when employment is low and labor markets are tight, job opportunities are plentiful. These kinds of conditions serve as a deterrent to retirement and may even induce some workers to come out of semi-retirement and return to the labor force. On the other hand, when unemployment rates are high, as is our experience now, not only are job opportunities limited but many workers are laid off from their jobs due to depressed demand. Since alternative jobs are difficult to find for the older worker, many of them will opt for retirement once unemployment benefits run out. This amounts to a form of involuntary retirement.

*Grad, Susan. "New Retirees and the Stability of the Retirement Decision," SSA Bulletin, March 1977.

During the most recent recession period, joblessness reached an all-time record high for persons 55 or older. The unemployment level for older Americans in the age 55+ age group increased 59 percent in slightly more than a year, from 526,000 in August 1981 to 838,000 in October 1982. This represents the highest level for persons 55 or older since monthly unemployment data were first tabulated in 1948.

Despite the new recognition that what goes on in labor markets is important to older persons and to the retirement systems that serve them, those markets do not perform particularly well for this segment of the population, especially the unemployed older worker. Unemployed workers 55 years of age or older remain out of work an average five to ten weeks longer than their younger counterparts. When the older worker is able to return to work, he or she typically is paid $1,500 per year less than the previous job while the age 35 worker typically receives only $500 less. (Report of House Select Committee on Aging, October 1982).

The "discouraged worker" phenomenon is also prevalent among older workers. Persons over 55 years of age contain the single largest population of persons discouraged from the job search because of job market reasons. Among males under 55 there are 4 discouraged workers for every person counted as unemployed while among those 55 and above, there are 37

discouraged for every person in the unemployed category. In 1982, there were an estimated 334,000 discouraged workers age 55 and older. These workers often lose employer-sponsored health insurance coverage at a time in their lives when they are most likely to need coverage and least able to afford purchasing it privately.

Much of the labor force participation trend which has been described took hold before the high inflation rates of recent years became a phenomenon in the structure of the economy. Being unsure about the future real value of non-indexed retirement income, such as private pensions and other savings and assets, older workers may prefer to remain in a full-time employment to hedge against the undesirable effects of anticipated inflation. While the older person is relatively protected from inflation, since over time wages tend to keep better pace with inflation than other forms of retirement income. Also, by working longer, individual retirement benefit levels are sometimes increased. Although higher benefits do not mitigate the effects of inflation, they do provide an added measure of income protection.

A nation-wide poll of persons 55+, conducted in November 1982 by the Washington polling firm of Hamilton and Staff for our Association, found that overall, two-thirds of retirees in the group were glad they had retired. However, among lower income groups with incomes under $4,000 a significant 65% of the retirees said they would rather be working. Among the respondents still working, 74% were glad of it while only 21% said they would rather retire.

What is important to recognize in examining these trends is the fact that more and more older persons, at earlier ages, are becoming dependent for income on sources other than employment and that this trend has shown signs of accelerating. Table I on the following page demonstrates this trend. For all four age groups, income from employment declined in importance over the ten-year period 1967-1977 while the share of income from assets increased. Table II demonstrates the particularly high degree of dependence of low-income persons on public transfer programs like social security and their lack of wage and salary income.

TABLE I

INCOME SHARES BY SOURCE

	1967	1977
Age 55-61		
Wages and Salaries	76.6	70.9
Social Security	1.6	3.1
Asset Income	5.2	7.6
All other	16.6	18.4
Age 62-64		
Wages and Salaries	67.3	50.0
Social Security	7.6	15.3
Asset Income	7.9	11.3
All other	17.2	23.4
Age 65-71		
Wages and Salaries	34.3	20.9
Social Security	27.6	38.0
Asset Income	14.2	17.0
All other	23.9	24.9
Age 72 & over		
Wages and Salaries	10.9	5.7
Social Security	43.0	48.3
Asset Income	19.5	22.9
All other	26.6	23.1

Source: Inflation and the Elderly - Part II, report prepared by Data Resources, Inc. for NRTA-AARP, January, 1980.

TABLE 11

SOURCES OF INCOME FOR CONSUMERS AGES 55 & OVER
IN 1976 BY AGE OF HEAD

SOURCE: MARCH 1977 CPSADF - FAMILIES FROM PERSONS

	UNDER $5K	$5K TO $10K	$10K TO $15K	$15K TO $20K	$20K TO $25K	$25K & OVER	ALL INCOMES
COUNTS.....	8,521.25	7,032.73	4,098.30	2,880.97	1,782.73	2,762.39	27,078.37
MEAN PRE-TAX INCOME ($)....	3,087.32	7,171.55	12,268.06	17,205.59	22,185.02	36,564.32	11,712.13
WAGES & SAL. (%).....	10.75	25.76	48.81	61.91	70.77	68.17	35.66
NONFARM SELF EMPL. (%).....	0.70	2.32	3.74	4.64	4.97	8.11	3.04
FARM SELF EMPL. (%).....	0.79	1.37	1.90	1.47	1.21	2.48	1.38
SOCIAL SEC. & R.R. RET. (%)	64.61	41.46	18.72	9.84	5.70	3.25	35.69
SUPP. SECURITY (%).....	8.07	1.51	0.30	0.18	0.14	0.04	3.01
INTEREST (%).....	4.56	7.65	7.60	6.31	4.57	5.76	6.13
DIV. RENT & TRUST (%).....	0.27	3.67	3.91	4.61	3.62	6.08	2.98
WELF. & PUB. ASSIST (%)....	2.76	0.61	0.29	0.12	0.12	0.03	1.10
UNEMPL. & WKMNS COMP. (%)..	4.09	3.42	2.79	1.54	1.58	0.71	2.98
PENSIONS (%).....	3.35	11.78	11.32	8.72	7.05	5.11	7.74
OTHER (%).....	1.08	0.63	0.78	0.36	0.33	0.31	0.71

Source: Inflation and the Elderly - Part II, report prepared by Data Resources, Inc. for NRTA-AARP, January, 1980.

Strong Work Incentives Needed

In view of all of the trends previously described, it should be apparent that government policies which create incentives for early labor force withdrawal of older workers are imposing serious and unnecessary costs in our economic system and are making it more and more difficult for older persons to maintain adequate standards of living in their later years. These policies must change.

In the context of social security, our Association has felt that the best response to closing the system's long-term gap is to pursue an aggressive older worker promotion strategy rather than to raise the social security "normal" retirement age. Even though the social security retirement age will be increased to 67 in the next century and even though this action (in combination with other reforms) is expected to close the system's long-term gap, we believe stronger work incentives still need to be pursued in social security.

The current social security benefit structure with its weak post age 65 retirement incentives and early retirement penalty fails to induce the majority of older workers to elect the "normal" retirement age of 65, let alone induce workers to postpone retirement past that age. The raising of the retirement age to 67, as scheduled in the next century, is likely to fail in a similar manner since the age 67 plan merely replicates the current, rather ineffective, social security retirement structure.

We recommend two near-term changes in social security to induce older persons to remain fully employed past age 65. These changes are: a phase-out of the earnings limit for persons age 65+ and an increase in the delayed retirement credit to at least 8%. The recent social security amendments made improvements in these two areas, but fell short of the aggressive work promotion strategy we had in mind. Beginning in 1990, under PL 98-21, the social security earnings limitation will be liberalized so that benefits will only be reduced by $1 for every $3 which the older worker age 65-70 earns above the earnings limit amount. Currently, benefits are reduced by $1 for every $2 which the older worker earns over the limit of $6,600 (this limit increases automatically every year according to general wage increases). PL 98-21 also provides for a gradual increase in the delayed retirement credit from the current 3% to the actuarially-fair level of 8% over the 1990-2008 period. This delayed retirement credit is a benefit bonus available to persons who postpone filing for social security benefits until after age 65.

Although these liberalizations will provide some increased incentives for older persons in the future to continue to work past age 65, the Association believes it is still necessary to seek phase-out of the earnings limit and at the same time coordinate this phase-out with an increase in the delayed retirement credit. These two changes should be accomplished over a relatively short period, perhaps 1990-95. The Association

worked successfully with Senator Nancy Kassebaum on a Senate floor amendment to achieve this coordinated improvement in the earnings limit and delayed retirement credit, but this provision was unfortunately dropped in conference.

We understand that concern has been expressed about the "cost" of such reforms. However, we would point out that having factors in social security that cause people to limit their work effort imposes a significant "cost" on society. We are convinced that the economic "cost" in terms of lost production and lost tax receipts that results from just having the earnings limitation in place is greater than the "cost" of the additional social security outlays that repeal would entail.

An important article on the subject of cost was published in the September 1979 Social Security Bulletin. It is entitled, "Tax Impact for Elimination of the Retirement Test," and is authored by Josephine G. Gordon and Robert N. Schoeplein of the Office of Research and Statistics, SSA. This study concluded that elimination of the retirement test for workers age 65-69 would generate an additional $678.6 million in payroll taxes and an extra $997.8 million in federal individual income taxes. This additional revenue, when combined ($1.656 billion), would offset 79% of the $2.1 billion SSA had estimated at that time it would cost to repeal the test. In addition, it has been estimated by SSA that it costs more than $68 million per year to administer the test due to the complicated forms and periodic reporting that it necessitates.

Some analysts argue that higher income persons would exclusively reap the benefits of eliminating the earnings limit. These analyses ignore the fact that over half of workers age 65+ seem to arbitrarily hold their earnings below the earnings limit and they would also benefit from repeal of the limit. Their benefit would be in the form of the higher wages which they could earn, not in the form of higher social security benefits. SSA statistics reflected in the following table indicate that in 1980, 53% of male workers age 65+ kept their earnings below $5,000 (the earnings limit in effect at that time).

TABLE III Number & percentage distribution of workers with taxable earnings, by amount of earnings and sex, 1980

AMOUNT OF EARNINGS	MEN 65+	WOMEN 65+
Total Number	2,520,000	1,583,000
Total Percent	100	100
Less than $5,000	53%	68%
$ 5,000 - 9,999	18%	17%
$10,000 - 14,999	9%	8%
$15,000 or more	20%	7%

Source: Income of the Population 55 and Older, 1980
SSA Publication No. 13-11871

In addition to this social security work strategy, other complementary changes are needed relating to, for example, mandatory retirement practices. In 1978, Congress enacted amendments to the Age Discrimination in Employment Act (ADEA) that prohibit mandatory retirement before age 70, with a few exceptions, and protect most federal employees completely against age-based retirement. These amendments, however, did not go far enough. The Association recommends that forced retirement based solely on age should be completely prohibited under ADEA. Statutory sanctions which exist in current law, such as the bona fide occupational qualification provision, should be eliminated. Finally, the Equal Employment Opportunity Commission should enforce the ADEA as vigorously as possible to assure that the Act's full potential is realized in the case of middle-aged and older workers who continue to be victims of various discriminatory practices.

Another area in need of change is the law which mandates that states reduce a person's unemployment compensation by the amount of any pension income received. Although the law was amended in 1980 to limit the applicability of the offset, a person's unemployment compensation will still almost always be reduced by one-half of the amount of any social security benefits received. The Association recommends that the unemployment compensation offset be repealed in its entirety.

Another existing work disincentive relates to the Medicare "working aged" provision. As a part of the 1982 tax bill,

Congress enacted a provision which requires employers of older workers to be their primary health insurance payor. Under current ADEA regulations workers who are eligible for Medicare generally have Medicare act as the primary payor, with the employer's insurance becoming the secondary payor. The Association fears that the new rule will force up the costs of insuring older workers and act as a strong disincentive to employing them. Efforts should be made to change the law to equalize the benefit cost between younger and older workers.

As a means of providing employers with incentives to employ and/or retain older workers, the federal tax structure appears to be the most appropriate vehicle. For example, the employer portion of the social security payroll tax paid with respect to older workers could be reduced or eliminated through the income tax. A tax credit for a certain portion of the older worker's wages could also be used to encourage employers to hire them. Such changes would effectively reduce the cost of hiring older workers, and would also tend to counter any disincentive effect that the minimum wage might have on an employer's willingness to hire or retain an older worker. In addition, the tax laws could be used to encourage employers to introduce a host of job training, retraining, part-time and flexi-time programs aimed at older workers.

To complement the other components of an older worker employment strategy, increased job opportunities must be made available to older workers through federal employment programs, such as the Senior Community Service Employment Program (SCSEP) under Title V of the Older Americans Act.

III. THE NEED TO ENCOURAGE PRIVATE PENSIONS AND SAVINGS

As a means for relieving future demographic pressures on government income support programs, private pensions and savings should be promoted as sources of income for the future elderly. Two major factors, social security's financing mechanism and its future financing problems make it unlikely that social security alone could ever provide an adequate retirement income and displace the private pension system.

Social security is funded on a pay-as-you-go basis. That means that current payroll tax receipts are used to pay current benefits. However, in the case of private pension plans, assets are set aside in trust to cover benefit obligations as they accrue. Thus they are said to be advance funded.

Advance funding of a portion of the cost of providing an adequate income for the future elderly is increasingly desirable as a matter of public policy. That would assure that the post World War II baby boom population will, in effect, have savings of their own, and will not be totally dependent on a pay-as-you-go system for retirement income. A pay-as-you-go system, such as social security, would have to increase tax rates sharply to provide an adequate level of income for future retirees at a time when the worker/retiree ratio will be diminished. Additionally, since advance funding provides savings to finance investment, the private pension system is being looked upon increasingly as a mechanism for fostering economic growth.

While a portion of social security could be advance funded,

there would be serious problems with this approach. Control of a tremendous pool of capital would be centralized in a single source, and investment decisions might end up being removed from marketplace considerations.

Given these factors, the Association recommends that the private pension system be called upon to assume responsibility for providing a more significant and more universally available share of the income of the future elderly and that necessary changes be made to assure the full and efficient discharge of that responsibility. To start, present law (ERISA) should be amended to shorten vesting periods and a mechanism for pension portability should be designed and implemented. For example, a central clearinghouse could be created to act as a "bridge" between pension plans so that credits can be readily transferred when workers change jobs.

Additionally, ERISA's administrative requirements should not be so burdensome as to discourage small businesses from sponsoring pension plans. However, the basic protections for participants provided by the Act must not be lessened. Careful study should also be undertaken to determine whether the retirement planning tax incentives passed in 1981 sufficiently expand private pension coverage. If not, serious consideration must be given to a proposal offered in 1981 by the President's Commission on Pension Policy to require employers to provide a minimum level of pension coverage for their employees.

If the future elderly are to be better able to maintain their

living standards throughout their later years of life, ways must be devised to mitigate the effect of inflation on private pension benefits from the time they are awarded. Under the present legal framework, the Association knows of no mechanism for mandating cost-of-living adjustments without risking massive pension plan terminations by employers because of the large cost increases the making of such adjustments would entail. However, employers could be induced to provide at least some inflation compensation to their retirees through, for example, tax breaks, the extension of federal labor law to specify that retirees' benefits are a mandatory subject of collective bargaining, and the issuance by the federal government of indexed bonds that would be available to private pension plans and would guarantee a real rate of return on investment.

Also, retirees must have the opportunity to take part in their pension plan's decision-making process; for example, positions on the plan's board of trustees should be available to retirees. When investment returns make it affordable, retirees must be able to argue to plan sponsors that some portion of their plan's liberalizations should be devoted to cost-of-living protection for retirees.

In another respect, private pension plans are going to have to change to treat older workers more fairly than they presently do. Under a current Labor Department interpretation of ERISA and the ADEA, employers do not have to provide additional pension credits to workers who stay on the job beyond a plan's "normal"

retirement age (usually age 65). This interpretation discourages older workers by denying them any additional deferred compensation despite extra years of work. Moreover, these older workers may actually lose some of their benefits if the plan's payments do not commence until the worker retires. The Equal Employment Opportunity Commission, which enforces the ADEA, could change the interpretation in this area, but legislation appears needed to remedy the problem. Also, current laws which restrict a retiree's ability to work part-time without losing benefits and which prohibit plans from providing upward benefit adjustments to some people who work beyond their plan's normal retirement age must be changed.

Because women have a longer life expectancy than men, pension coverage could prove vital in supplementing social security benefits and such savings as may exist. However, due to the inequities built into the private pension system, women who work or who survive a spouse that had a vested pension right are less likely than men to receive pension income. Moreover, those women who do receive pension income often receive considerably smaller pension benefits on the average than men. The inequities inherent in the private pension system have contributed significantly to the fact that, in 1980, older women accounted for 71.5% of all elderly persons in poverty. In order to improve the situation of older women, there is an increasing need to enact legislation addressing such areas of pension law as eligibility, vesting, breaks in service, integration of benefits

with social security, and survivors' benefits.

In addition to expanding and improving the private pension structure, other forms of retirement savings need to be promoted. One problem facing the voluntary retirement income components of savings and pensions is the incentives created by the federal tax code. By allowing deductions for interest expenses, the tax code encourages consumption.

There are some tax benefits granted to private pensions, IRA's and Keogh's, and we are pleased that these tax benefits have been recently expanded in order to open up IRAs to more workers. Although current budget limitations constrain further expansion of savings incentives now, we hope the Committee will consider improvements in the future in light of demographic trends.

IV. LONG-TERM CARE

With so much concern being directed at the current problems in financing health care, the growing problem of long-term care has been largely pushed of the public agenda. However, four demographic factors require that Congress begin to address the problems of long term care sooner, rather than later.

1. A growing aged population -- Today only 11% of the population is age 65 or older. By the year 2015, over 18% of the population will be age 65 or older -- a significant increase with obvious implications for health expenditures. (30% of this nation's total personal health care expenditures today is accounted for by the elderly.)

2. Increased life expectancy among the aged --

Within the elderly population the age 75 and older subgroup is increasing most rapidly. By the year 2000, 45% of the elderly population will be in this category, compared to 39.5% at present. The proportion of the elderly who are aged 75 and older is important because the incidence of chronic disease and impairment and the utilization of medical services tends to increase with age, and increase dramatically after age 75.

3. Chronic disease as a dominant pattern of illness -- Millions of lives have been saved from acute heart attacks, strokes, early death from cancer, diabetes and other acute conditions. However, the more successful the nation's health care system has been in controlling acute disease and postponing death, the more chronic disease has tended to

become the dominant pattern of illness. By definition, chronic disease is never cured. According to the National Center of Health Statistics, for those 65 and over, 83% of all "restricted-activity days" in 1980 and 87% of all deaths in 1978 were due to chronic conditions.

4. Changing family patterns -- Today, the family tends to be smaller than was the case in the past. Smaller families mean fewer adult children caring for elderly parents in the home. Similarly, more working women, later marriages, more divorce, and greater geographical mobility portend less and less direct family care in the future.

While current budgetary constraints make it untimely to consider large expansion of services, at a minimum, the federal government should develop more rational -- and potentially more cost effective -- framework for long term care.

That framework should include roles for the individual, the family and the federal and state government. It is generally understood that the elderly are better served when they are helped in maintaining their independence in their homes and communities as long as possible. Although there are many programs to help older persons remain in their communities they tend to be fragmented and uncoordinated. Having been separately conceived, they are separately administered with separate criteria for establishing eligibility and need for service. For example, social services provided under Title XX of the Social Security Act and Title III of the Older Americans Act serve many of the same sites; though services may be identical,

eligibility criteria for recipients are entirely different. Furthermore, when it comes to in-home services, community services, special living arrangements, nursing home care and other forms of long-term care at the state or local level, there has been no serious, comprehensive effort from the federal level to encourage the coordination of these services within the community.

The family unit is an important contributor of supporting services and must not be ignored in the design of a comprehensive long-term care program. Family members now provide about 80% of the elderly's long-term care services. With limited resources, the goal must necessarily be to supplement--not supplant--family care activities. Certainly, disincentives to family assistance (such as the one-third reduction in benefits under SSI when the beneficiary lives with his/her family) should be removed. Moving in a positive direction, federal income tax credits could be created that would provide taxpayers with incentives to care for their dependent elderly in the home and to utilize adult day care facilities. A relatively small public investment in adult day care services and respite care services, to ease the burden on family members who are the primary care-givers, could help in providing an alternative to institutionalization of an older dependent family member.

A word of caution is in order regarding the ability of family members to care for or finance the care of an older member of the family. Simply put, as the number of very

elderly continues to grow, their sons and daughters will themselves be among the elderly or near elderly, and or retirement income.

Currently, the federal government spends more to maintain older persons in nursing homes than it expends on home care under Medicare and Medicaid, all social service and federal housing programs for the elderly.

But if an adequate supply of sheltered living arrangements and congregate housing, homemaker/home health care and other community-based services were available, it is likely that 30% of the present nursing home population could be cared for in less expensive settings.

Despite the economic and budgetary constraints that are impeding the development of a national long-term care program, additional modest steps can be taken that would build upon the progress made in the recent past. For example, with respect to home health services, Medicare's "homebound" and "skilled care" requirements should be eliminated and coverage of homemaker/chore services should be provided. In addition, a comprehensive pre-nursing home admission screening and assessment program for potential nursing home residents should be established. To facilitate a broader range of long-term care services (as well as preventive and primary care), Medicare beneficiaries are strongly encouraged to enroll in HMO's and similar alternative delivery systems.

Another step that could easily be taken entails the increased use and expansion of ACTION's Senior Companion Program. This program provides opportunities for low-income older persons to provide assistance and support to other older persons who, without this assistance, would probably be institutionalized. Senior Companions provide in-home services to assist impaired elderly individuals to remain at home, expedite earlier discharges from the hospital, comfort those in hospices, and provide companionship for the mentally ill.

Increased private sector involvement in meeting long-term care needs must also be explored. Private insurance companies should be encouraged to add long-term care benefits to existing policies and develop new policies which would specifically address the elderly's long-term care needs. Over the long term, health insurance accounts (similar to tax-deferred IRAs) could be created providing younger persons with an incentive to save for their future long-term care needs.

Senator CHAFEE. Well, thank you, Mr. Hacking. As always, you have made a constructive statement.

What do both of you gentlemen have to say about the figures of Dr. Keyfitz, in which, although you do not have the benefits of the charts, he shows that in taking his figures—as I understand them, they were based on what has happened in the past, and he extrapolated into the future, is that it?

He shows that in the year 2035, for every 1,000 workers producing, that is contributing to the social security system, age 20 to 65, there will be 519 people over 65 to support. What do you say about that, Dr. Hickman?

Mr. HICKMAN. I believe that they support the proposition that I stated, Senator Chafee, that it is going to be an important national policy to move the distribution of retirement ages upward. That does not need to be done abruptly and it does not mean that we have to have a fixed retirement age. But that distribution needs to be pushed upward, and I think that Dr. Keyfitz's statistics is a powerful support for that proposition.

Senator CHAFEE. What do you say, Mr. Hacking?

Mr. HACKING. We have seen different projections in terms of the worker-to-beneficiary ratio. I would just say that as an organization we tend to want to be on the safe side, and we tend to look, therefore, at the most pessimistic projections.

It is obvious to us that in the future, when the post-World War II baby boom population reaches old age and therefore benefit eligibility age, if we end up with two workers supporting each beneficiary, as opposed to 3.3 to 1 today, we are going to be in a very serious situation in terms of providing that beneficiary population with an adequate income.

Therefore, between now and the time that that population cohort reaches old age, a major effort has to be undertaken to make sure that a very substantially increased segment of that future elderly population is still in the work force relative to what is the case today. Because then you will have not just young workers, but also older workers, sharing in the cost of maintaining those older people at that time who cannot provide adequately for themselves.

Senator CHAFEE. OK. Well, thank you very much.

Well, gentlemen, just as we are concluding, it turns out that there is a vote. So we will draw this to a close.

I want to thank everybody for coming. Your testimony has been helpful. I think this is one of the few hearings I have ever attended where the witnesses have stayed to hear the other witnesses. That is a little unusual. Usually, first to come, first to leave. I think that we have some big challenges ahead of us here.

I think that I appreciate what Mr. Bayo said, I would guess, however, that the social security system is not really estimating what is going to happen, although, as Mr. Bayo and Dr. Hickman both stressed these things are gradual and there is time to compensate for them. Nevertheless, I believe that we have experienced some very, very dramatic changes in the American scene, and the implications are really of the most challenging nature.

It behooves us to do everything we can to make the workplace more attractive so that people will want to stay and work, instead

of, as Mr. Hacking's statistics indicate keeping it a place where people want to get out as soon as they can.

Mr. HACKING. Mr. Chairman, may I make one further remark?

AARP fully agrees with you that social security's financial problem has not been fixed for all time. We also think that some of the things that were done in this year's social security bill are going to aggravate the declining labor force participation trend that we talked about.

Senator CHAFEE. Such as?

Mr. HACKING. Well, for example——

Senator CHAFEE. In 30 seconds.

Mr. HACKING. I think we are going to have to do some close analysis of the effect of the taxation of benefits on work effort of people in old age. I do not think that was closely looked at in the context of the development of the legislation.

Senator CHAFEE. OK, fine.

Well, thank you all very much for coming. We appreciate it.

[Whereupon, at 12 noon, the subcommittee was adjourned.]

[By direction of the chairman the following communications were made a part of the hearing record:]

Mr. Roderick A. DeArment
Chief Counsel Committee on Finance
Room 219, Dirkson Senate Office Building
Washington, D.C. 20510

Subject:

The Effects of Projected Trends
in Life Expectancy

Increasing life expectancy is a mixed blessing. Some of the major problems are financial. Fixed pensions in an inflationary economy can gradually impoverish an individual or couple who had an adequate income at retirement.

We all hope we won't see double digit inflation again. However, with only 3% inflation, the cost of living can go up 81% in 20 years. At 5%, the increase can be 165%.

An increasing number of retirees can expect to live 20 years or more. The Social Security portion of retirement income helps the retiree keep up. However, most pension plans can't or don't keep up with any inflationary increase.

There is another related concern. This is the trend toward unisex annuity rates. Perhaps it is the time to reconsider whether the annuity is really the best way to settle the values in a defined contribution plan. There are a number of problems with the use of annuities for

retirement benefits. Among these are:

1. The question of sex discrimination.
2. If unisex annuities are mandated, many well informed males will reject the annuity option. This will gradually make the unisex annuity look more like a female annuity.
3. Fixed dollar annuities are not adequate to cope with inflation over a long retirement.
4. Some married couples refuse the survivor option because it reduces the income too much.
5. Most annuities are not capable of accurately reflecting the differing mortality of impaired lives.

There are now several alternatives available to those who choose not to use the annuity option at retirement.

1. A lump sum settlement. This is tax favored, but it is a poor solution to those who are not good at managing money. In many cases, these folks will run out of money before they die.
2. A fixed period payout. This, too is a poor solution for all but the sophisticated money manager. Certain provisions of the Internal Revenue Code require rather rapid payout of the funds. Generally, it must all be paid out by life expectancy. Chances are that each installment will be spent, creating an urgent problem for those unfortunate enough to outlive life expectancy. Perhaps this is an oversimplification, but that should amount to about one half of those who started. This can be a major cause of senior citizen poverty--and demands for more generous Social Security benefits.

There is a reasonable solution, but it will require legislative changes. Under current law, the tax penalties would make it unworkable.

Some years ago, Tom Wolff, CLU, a life insurance representative, saw how these same problems faced a widow trying to use life insurance settlement options to manage her husband's life insurance proceeds. His solution was the capital conservation idea. Here, the life insurance proceeds were invested. The beneficiary would receive an income that was somewhat less than the investment earnings. Excess earnings would be added to the fund each year--giving the widow a chance at keeping up with inflation.

I believe we can build on Tom Wolff's idea. It seems the capital conservation idea would fit retiring employees very well, in some cases. In addition to the choices now available, retiring employees should have this other choice.

The new choice--capital conservation--would work like this.

1. The funds would be maintained in the plan. Payments during the first year would be a fixed percentage of the initial fund balance. Each year, the percentage would be re-applied to the beginning balance for that year. The minimum payment allowed by law would be 4% or 5%. The law would provide no maximum, but the pension committee would be authorized to set a maximum.
   A. The payout percentage could be changed each year, within these limits.
   B. Unless the funds ran out sooner, payments would be continued until the later death of the retiree and the spouse. At the death of the last to die, any balance in the account would be paid to a named beneficiary or to the estate of the last to die. The final payout could be spread over five to ten years. All payments would be ordinary income for income tax purposes. Payments after

the second death could be fully includible for estate tax purposes. If a charitable beneficiary wre named,of course, no income or estate taxes would be due.

2. If chosen by the retiree, the funds at retirement could be placed in a charitable remainder unitrust, annuity trust, or pooled income fund. The distribution to the unitrust, annuity trust, or pooled income fund would create no taxable income nor tax deduction. (Income from the trust would, of course, be ordinary income.)

3. The law should also make capital conservation rollover IRA's possible. They could be used where the plan did not incorporate the capital conservation idea. They would also be used where the retireee wanted other investment choices than the plan offered.
4. The same arrangements would be made available for Tax Sheltered Annuities and IRA's.

Present law requires that pension funds be paid out rather quickly. It would seem there are two reasons. The first has to do with income taxes. Income taxes have been deferred on these funds for many years, in some cases. The Treasury feels it is time to remove the shelter and get some revenue. However, the shelter was created originally to achieve socially desirable ends. This proposal would defer some of that revenue a little longer. That seems a small price to pay to meet the socially desirable ends more effectively.

The second reason for the haste to get the money paid out would seem to be connected with estate taxes. Under preTEFRA law, money kept in the shelter could also escape estate taxes. Under TEFRA, only $100,000 can be exempt

from Federal Estate Taxes. Under this proposal, settlements using capital conservation might even be denied this minimal shelter. This would recapture some of the deferred income taxes.

This capital conservation proposal would give retiring employees a better chance to maintain a reasonable standard of living in retirement. It would seem that when pension law is revised, this needs to be part of the revision.

I need to emphasize that this should be permissive, not mandatory. Where the plan sponsor wanted to offer a capital conservation settlement, it could be included. Where the plan did not include this option, the retiree would be allowed, but not required to use this concept. He would do so under the provision for rollover IRA. People with TSA's and IRA's would also have this available as an option.

James R. Dudeck

James R. Dudeck, CLU FLMI
6809 Provost Road North
Jacksonville, Florida 32216

THE IMPACT OF BIOMEDICAL ACCOMPLISHMENTS ON LIFE EXPECTATION AND LIFE SPAN

by

DR. LEONARD HAYFLICK
Professor and Director
Center for Gerontological Studies
University of Florida, 3357 GPA
Gainesville, Florida 32611

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Of all the conflicting views on the causes of biologic aging, few gerontologists disagree with the axiom that after reaching sexual maturity and cessation of growth, animals accumulate physiologic decrements that lead to an increase in their likelihood of dying. In fact, for humans, the data, first analyzed by the English actuary Gompertz in 1825, reveal that the force of mortality doubles every 7 years after the age of 30. That is, after maturity, the rate and probability of dying are exponential with increasing age. A variety of human physiologic functions, although subject to some individual variation, show a slow, nearly linear decline from 30 years of age. The rate constants for this linear loss seem to occur at about 0.8 to 0.9 percent loss per year of the functional capacity present at the age of 30 (1).

The common impression that the triumphs of modern medicine have lengthened the human lifespan is not supported by either vital statistics or biologic evidence. The fact is that in the developed countries, the prevention and treatment of those ills which caused deaths in the early years have improved. Consequently, more people are reaching what appears to be an immutable, upper age limit. Thus life expectation has increased (Figure 1), but the human lifespan has remained virtually unchanged since recorded history. Medical achievements have simply allowed more people to approach the limit of that fixed lifespan. Deaths in the early years are becoming increasingly less frequent in the developed countries, resulting in life tables that are simply becoming more rectangular, as indicated by the direction of the arrow in Figure 2. In many privileged countries, one can now expect to become reasonably old which is a relatively new phenomenon (Figure 3). The benefactors of biomedical triumphs in the 20th century have been members of the younger age groups. This has been substantially due to the

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resolution of the deaths caused by infectious diseases. The development and use of vaccines and antibiotics have achieved this stupendous success (Figure 4).

EFFECTS OF THE RESOLUTION OF DISEASES

If cardiovascular diseases, which are now the leading cause of death in the United States, are successfully conquered, approximately 12 years of additional life can be expected (Table I). If the second greatest cause of death -cancer- is eliminated, about 2 years of additional life expectation will result. The net increase in life expectancy at birth achieved in the United States from 1900 to 1950 was almost 20 years. This increase resulted from the decrease in the large number of deaths that occurred before the age of 65. However, the gain in life expectancy at 65 and 75 years of age from 1900 to 1969 was, respectively, only 2.9 and 2.2.

What would be the effect on human longevity and the human lifespan in a a world in which all causes of death resulting from causes reported on death certificates (diseases and accidents) were totally eliminated (Table I)? The effect on human longevity would be to realize the ultimate rectangular curve (Figure 2) in which citizens would live out their lives free of the fear of premature death, but with the certain fate that their normal physiologic decrements would result in death on about their 100th birthday.

These concepts have forced gerontologists to the conclusion that the disease-oriented approach to medical research might increase life expectation but will have little impact on increasing the human lifespan. If such an increase is desirable (and there is considerable doubt that it is), one must first separate the disease-related causes of death from the age-dependent

normal physiologic decrements that give rise to the manifestations of old age. The diseases of old age are simply superimposed on these normal physiologic decrements but must be separately regarded to consider ways of increasing the human lifespan. Although age-associated physiologic decrements surely increase vulnerability to disease, the fundamental causes of death are not diseases, but the physiologic decrements that make their occurrence more likely.

Biomedical research has trained its heavy artillery almost exclusively on the disease-associated causes of death. Scant attention has been paid to the underlying causes of biologic aging that are not disease-associated, but which, in clocklike fashion, dictate for each species a specific maximum lifespan. To be sure, the physiologic decrements that occur in advancing years increase vulnerability to disease, but unless more attention is paid to the fundamental non-disease-related biologic causes of aging, the fate of each person will be death on about his or her 100th birthday.

PROSPECTS FOR INCREASING HUMAN LONGEVITY

As stated, there are two ways in which the efforts of biomedical research can be expected to extend human longevity in the next 25 years. The first is to reduce or eliminate the major causes of death. For most developed countries, this would mean eliminating cardiovascular diseases and cancer. In the developing countries, (and in some areas of developed countries) life expectancy can be extended by the simple expedient of motivating the political and economic infrastructure to provide citizens with the necessary food, hygienic conditions, and medical care that are commonplace in most developed countries. The results of reducing the effect of minor

diseases in developed countries will be minimal. For example, in the United States, if tuberculosis were completely eliminated, the gain in life expectation at birth would be less than 0.05 year (Table I). Thus it could be argued that if an increase in life expectation becomes the main goal of biomedical research in the developed countries, all such research should be directed toward the elimination of the two major causes of death. This position, although less than humane and not likely to attract many adherents, is nonetheless the most logical conclusion to be drawn from life-table studies and the projections dealt with in Table I.

The second way in which biomedical research can deal with human longevity is to address itself specifically to the underlying non-disease-related fundamental causes of age changes. These non-diseases are the basic biological changes that result in the physiological decrements characteristic of aging. On these changes is superimposed an increasing vulnerability to disease. Such an approach, then, does not directly concern itself with efforts to increase human life expectation but rather to extend what appears to be a fixed lifespan.

As a measure of the current effort put forth toward these two approaches, funds spent in the United States on cardiovascular disease and cancer research are about twenty times greater than the funds spent in gerontology. It is also probable that the number of researchers, and consequently the amount of effort, in both these areas also differs by twenty-fold. Consequently, the likelihood that any significant increase in human longevity will occur in the next 25 years depends on (1) significantly better cure rates for cardiovascular diseases or cancer or both, and (2) significant advances in our understanding and ability to manipulate the biological clocks that set a maximum lifespan for each species, or a combination of (1) and (2).

If potential success in either of these endeavors can be measured by the current attitudes and priorities of the biomedical research establishment in the United States, then clearly the search for cardiovascular disease and cancer cures are much more likely to affect human longevity than is gerontological research. A further conclusion is that by resolving these two diseases, a maximum of 14 years of additional life expectation could be attained, but with successful efforts to increase the lifespan itself, no fixed end point is ruled out. Furthermore, the resolution of the two leading killers will in no way reverse or halt the decline in physiologic decrements characteristic of age changes, whereas efforts to increase the lifespan could lead to such a reversal. Clearly, research in cardiovascular diseases and cancer should not be stopped, but if our goal is to maximize opportunities to effectively increase human longevity, then our current priorities are seriously out of balance. If this imbalance continues unchanged, there is little likelihood that the research accomplishments of a handful of underfunded gerontologists will affect the human lifespan.

DEMOGRAPHIC PROJECTIONS

That the proportion of persons in developed countries over the age of 65 has been steadily increasing is well known. In the last 100 years, their proportion of the total population in the United States has increased from 3.4 to 11.6 percent (Figure 5), and the aged have become a larger proportion of the nonworking component of the population, which includes the nonworking youth. This nonworking population component is largely supported by the

workforce itself, and if current population trends continue, the elderly will command increasingly more support.

Within 50 years, those over 65 are expected to number nearly 40 million in the United States (Figures 6 and 7). This prediction does not take into account any major resolution within 50 years of the two leading causes of death -cardiovascular disease and cancer. If some significant cure rate were to occur, however, the United States might have as many persons over 65 as under 15 in the year 2025.

If zero population growth were to be achieved in the United States and maintained, the family size of old persons would obviously be reduced, and along with that reduction would be a diminution in the economic, social, and psychological benefits that now accrue from adult children. The inevitable consequence could be a further acceleration of current trends, in which governments would provide more health care, food, housing, recreation, and income to the elderly.

Since zero population growth might be achieved in a number of countries by the year 2025, it is interesting to speculate on the consequences of another extreme condition -a population in which no one dies at all. The immediate effect on the growth rate of the total population would be significant, since the growth rate would be increased by the amount of the current death rate. In the long run, however, the increase would not be dramatic (2). The increase in growth rate would be somewhat less than one-half million persons per year in the United States population of 250 million -that is, over and above the number of births now being added to the population each year. (For example, in 1974, the number of births was approximately 3 million. With no mortality, the number of births would be an additional

one-half million, based on the projection that those females who now die in childhood would survive and would bear children.)

Therefore, even the stupendous achievement of attaining biologic immortality would not greatly increase the total population- that is, if those achieving biologic immortality did not concomitantly gain in fecundity. However, even a steady-state annual increase of one-half million persons greater than the present annual increase of 3 million would make a significant impact after several years.

After the initial large impact of a shift to zero mortality, the rate of increase of the elderly would change slowly. Because, with the current life expectancy of 74 years, any large reductions in death rates would be limited to persons over 60, the elimination of all death would increase the proportion of older people. If the birth rate were to decline to zero- the most unlikely event of all- than obviously the population would eventually consist entirely of centenarians and then of supercentenarians.

AGING IN THE 21ST CENTURY

Predicting the course of scientific progress is inherently unscientific. It is not possible to anticipate future discoveries or is it possible to assess accurately the social, political, and economic forces that are playing an increasingly larger role in scientific direction. For these principle reasons I approach an analysis of the biology of human aging 50 years hence with considerable trepidation. One comforting factor, however, is that the scientific method does allow for extrapolations from existing data, and it is with that license that I intend to analyze what human longevity might be in the year 2025 A.D.

If future events can be predicted from past experiences, then the impact of biomedical research on human longevity in the next 50 years in this country should be to extend life expectancy at birth considerably beyond the present 74 years. Yet the likelihood of a net increase occurring by the year 2025 of the magnitude seen since 1900 is very doubtful. Life expectancy at birth in 1900 was about 49 years and in 1950 it was about 68 years -a net gain of 19 years. Since 1950, however, the gain has been only 2.4 years, and since 1969 the gain has been about 1.2 years (3).

Why has there been such a profound increase in life expectation in the first half of this century and, in the beginning of the second half, an equally profound leveling off? That this has occurred is even more impressive if one accepts the common notion that the extent of advances made in biomedical research in the past 30 years has been greater than those made in all previous years. As a result of biomedical achievements, more people are reaching the limit of what appears to be a fixed life span. Deaths in the early years are becoming increasingly less frequent, resulting in life tables that are simply becoming more rectangular as indicated in Figure 2. In many privileged countries, you can now reasonably expect to become old, which is a very new phenomenon, indeed (Figure 2).

In any attempt at "futurology" it is wisest to base predictions on similar events that may have happened in the past. To the question, what will be the impact of achieving by 2025 a 5-, 10-, or even 20-year increase in human life expectancy, we have only to look back at the same question being asked in 1900. For it was during the period 1900-1975 that increases in human longevity of these magnitudes did indeed occur. It is, therefore, safest to conclude that any further increase in human life expectancy is likely to incur the same sets of problems and solutions to those problems

that occurred in the model system that embraces the first three-quarters of this century. The question then is: To prepare for a potential increase in human longevity, what should we now do that is different from what was or was not done in 1900? The chief medical problem during the first half of the twentieth century was infectious diseases and the chief biomedical accomplishment during that time was their virtual elimination. As a result society now finds itself burdened with unprecedented numbers of disabled and indigent old people who have survived infectious diseases but who will not survive old age. We do not wish to prolong old age by keeping people alive well beyond their years of vigor; medical science has essentially achieved this dubious goal. What we want to do is to maintain maximum physical and intellectual vigor up to the limit of the human lifespan.

As to making predictions about the future likelihood of increasing human longevity, some consideration should be given to two efforts in which such prognostications have been made. Both of these studies were conducted by eliciting the opinions of scientists as to their expectations. Polls are a poor way to conduct scientific research, but for what they might be worth the results were as follows. In the Rand Study, (4) scientific prognosticators concluded that an increase in longevity of 50 years will occur by the year 2020. In the Smith, Kline and French study (5) a median estimate of a 50-year increase in longevity is considered attainable by the early 1990s. I find these expectations unreasonably optimistic for the following reasons.

Since the life expectancy has increased so dramatically since 1900, anyone could foresee the possibility of some small degree of further extension. All that needs to be done is to better the hygienic, health care, and nutritional deficiencies of the substantial proportion of people now denied these basic human needs. Thus there is no requirement for a new intellectual

basis of understanding the biology of aging materially to increase the longevity of a substantial portion of our society. All that it takes is motivation and money. This achievement would increase life expectancy but, of course, would not affect the lifespan or the rate of aging. Nevertheless, it is something that could be done now without requiring any new scientific innovations. For significant increases in longevity to take place as forecasted by the Rand and Smith, Kline and French Studies, spectacular scientific achievements will be necessary. To increase life expectancy at birth by 11.8 years, resolution of all cardiovascular diseases and stroke would have to occur (Table 1). To increase longevity by 2.5 years at birth, cancer would have to eliminated (Table 1). Both accomplishments would yield a net gain of about 14 years; but beyond that, significant extension would occur only by understanding the basic mechanisms of age changes and having the ability to slow the rate or otherwise manipulate the clock. The likelihood that either or both of these events will occur in the next 25 to 50 years is, in my judgment, very doubtful.

The conclusion to be reached is that if, in the next 50 years, biomedical research was to triumph to the extent that deaths caused by cardiovascular disease, stroke, and cancer would be preventable, a net increase in life expectancy of about 14 years would occur. Advances made in preventing deaths caused by other diseases would not have much impact on human longevity. The greatest potential impact on human longevity would be research directed toward reducing the rate of the fundamental non-disease related biological causes of age changes, which are undoubtedly genetically determined.

However, if our social, political, and economic institutions are likely to be severely dislocated by these achievements, what right do we have to encourage this goal? Our success, if it can be called that, in increasing

life expectancy from about 50 years in 1900 to about 74 years in 1983, has not resulted in any concomitant treatment of the elderly for which we can be proud. If we haven't learned how to manage our social support system for 22 million elderly in 1983, what is the likelihood that we will do better for 28 million in 1990 or 40 million in 2025? Until better solutions for control of chronic diseases are forthcoming, the economics of building sophisticated high-technology life-support systems and the ethics of pulling the plugs will be agonized over to a far greater degree in 2025. A new ethical system must surely emerge regarding heroic measures to prolong nonproductive or vegetative life. Under these circumstances, death is postponed, but aging is not.

Biomedical successes, for which we are all presumably grateful, have virtually eliminated deaths in the early years and have permitted more people to grow old. Rather than celebrate this triumph the public attitude has been to regard the increasing numbers of older people as a burden which society must endure rather than rejoice in. The prevailing negative attitude toward the burgeoning number of older people is tantamount to lamenting the increased numbers of younger persons resulting from the baby boom as an equivalent burden that society must endure.

As a society we did not suggest denying the growing youth population an education because of costs. Our task is to make adjustments and plans which will allow us to cope with all demographic changes positively and humanely.

TABLE 1.

GAIN IN EXPECTATION OF LIFE AT BIRTH AND AT AGE 65 DUE TO ELIMINATION OF VARIOUS CAUSES OF DEATH. 1969-71

CAUSE OF DEATH	GAIN (YR) IN EXPECTATION OF LIFE IF CAUSE WAS ELIMINATED	
	At birth	At age of 65
Major cardiovascular-renal diseases	11.8	11.4
Diseases of the heart	5.9	5.1
Cerebrovascular diseases	1.2	1.2
Malignant neoplasms*	2.5	1.4
Motor vehicle accidents	0.7	0.1
All accidents excluding motor vehicles	0.6	0.1
Influenza and pneumonia	0.5	0.2
Diabetes mellitus	0.2	0.2
Infectious and parasitic diseases	0.2	0.1
Tuberculosis	Less than 0.05	

* Including neoplasms of lymphatic and hematopoietic tissues.

Source: U.S. Public Health Service, National Center for Health Statistics, "U.S. Life Tables by Causes of Death: 1969-71," by T.N.E. Greville, "U.S. Decennial Life Tables for 1969-71," Vol.1, No. 5, 1976.

FIGURE 1

AVERAGE LENGTH OF LIFE FROM ANCIENT TO MODERN TIMES

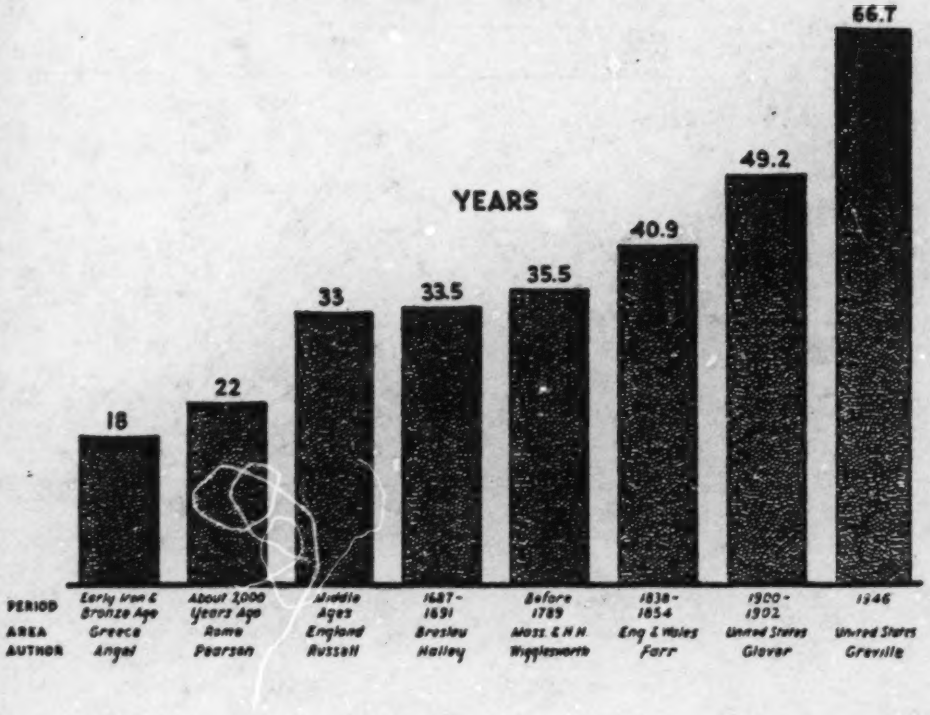


FIGURE 2

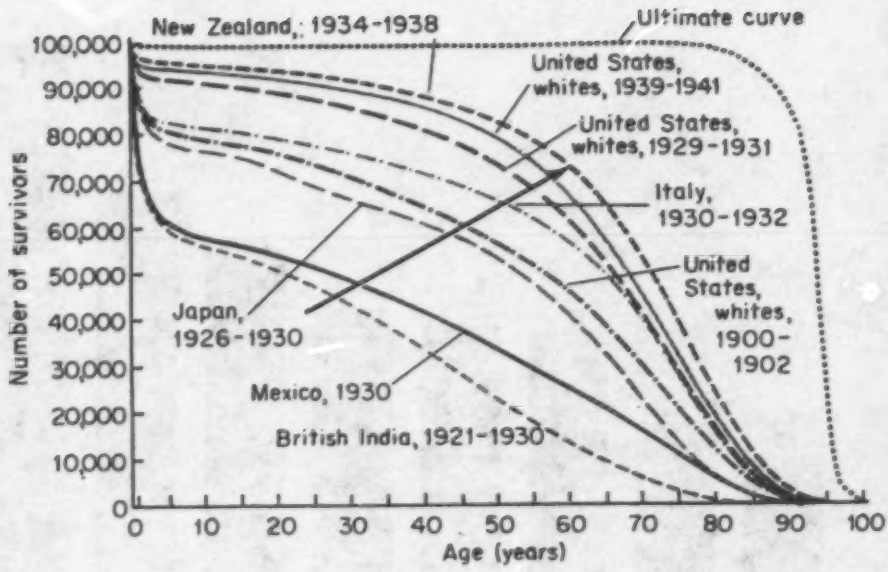

New Zealand, 1934-1938
Ultimate curve
United States, whites, 1939-1941
United States, whites, 1929-1931
Italy, 1930-1932
United States, whites, 1900-1902
Japan, 1926-1930
Mexico, 1930
British India, 1921-1930
Number of survivors
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
0
10
20
30
40
50
60
70
80
90
100
Age (years)

FIGURE 3

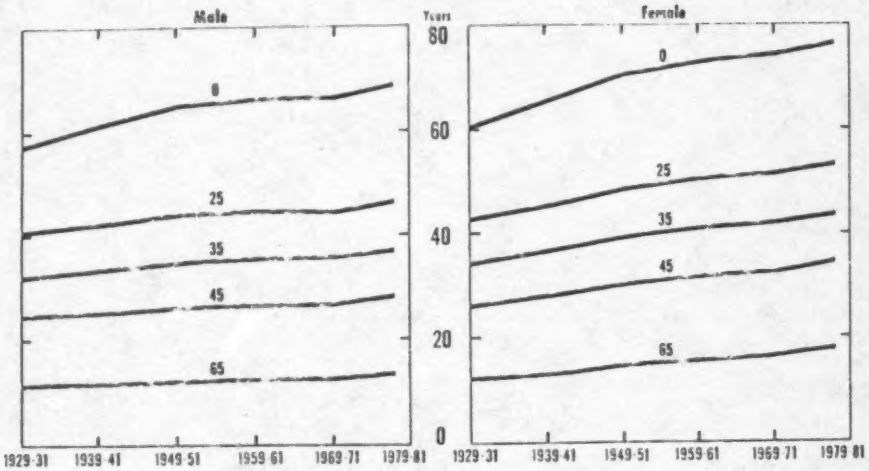
LIFE EXPECTANCY AT BIRTH, SELECTED COUNTRIES

[Adapted from United Nations Demographic Yearbook]

Males				Females		
Rank	Country	Date	Years	Rank	Country	Years
1	Norway	1977–78	72.31	1	Norway	78.65
2	Sweden	1974–78	72.23	2	Netherlands	78.4
3	Japan	1976	72.15	3	Sweden	78.14
4	Netherlands	1977	72.0	4	France	77.85
5	Denmark	1977–78	71.5	5	Denmark	77.5
6	Israel	1978	71.46	6	Japan	77.35
7	Switzerland	1968–73	70.29	7	United States	77.2
8	Greece	1970	70.13	8	Finland	77.12
9	France	1977	69.73	9	Canada	76.36
10	Spain	1970	69.69	10	Switzerland	76.22
11	England and Wales	1974–76	69.62	11	England and Wales	75.82
12	United States	1978	69.5	12	Germany (Federal Republic)	75.64
13	Canada	1970–72	69.34	13	Austria	75.6
14	Germany (Federal Republic)	1976–78	68.99	14	Poland	75.0
15	Italy	1970–72	68.97	15	Israel	74.98
16	Germany (Democratic Republic)	1976	68.82	16	Spain	74.96
17	Ireland	1970–72	68.77	17	Italy	74.88
18	Bulgaria	1974–76	68.68	18	New Zealand	74.6
19	New Zealand	1970–72	68.55	19	Germany (Democratic Republic)	74.42
20	Austria	1977	68.54	20	Belgium	74.21
21	Cuba	1970	68.5	21	Australia	74.15
22	Finland	1978	68.49	22	Czechoslovakia	74.12
23	Belgium	1968–72	67.79	23	U.S.S.R.	74.0
24	Australia	1965–67	67.63	24	Bulgaria	73.91
25	Romania	1976–78	67.42	25	Greece	73.64
26	Poland	1975–76	67.3	26	Ireland	73.52
27	Czechoslovakia	1977	66.99	28	Romania	72.06
40	U.S.S.R.	1971–72	64.0	30	Cuba	71.8

FIGURE 4

Expectation of Life (in years), at Selected Ages
United States 1929-1977



Note: 1929-31, estimated from data for white and Negro.

FIGURE 5

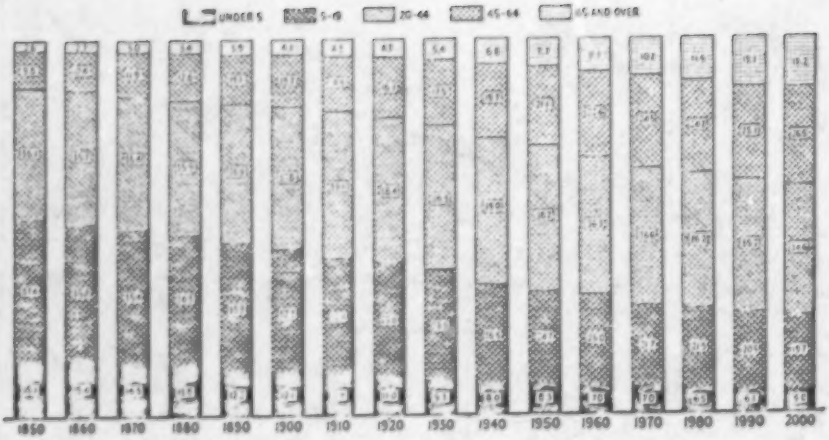

UNDER 5
5-19
20-44
45-64
65 AND OVER
1850
1860
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000

FIGURE 6

Growth of the Population 65 Years and Over: 1900 to 2020

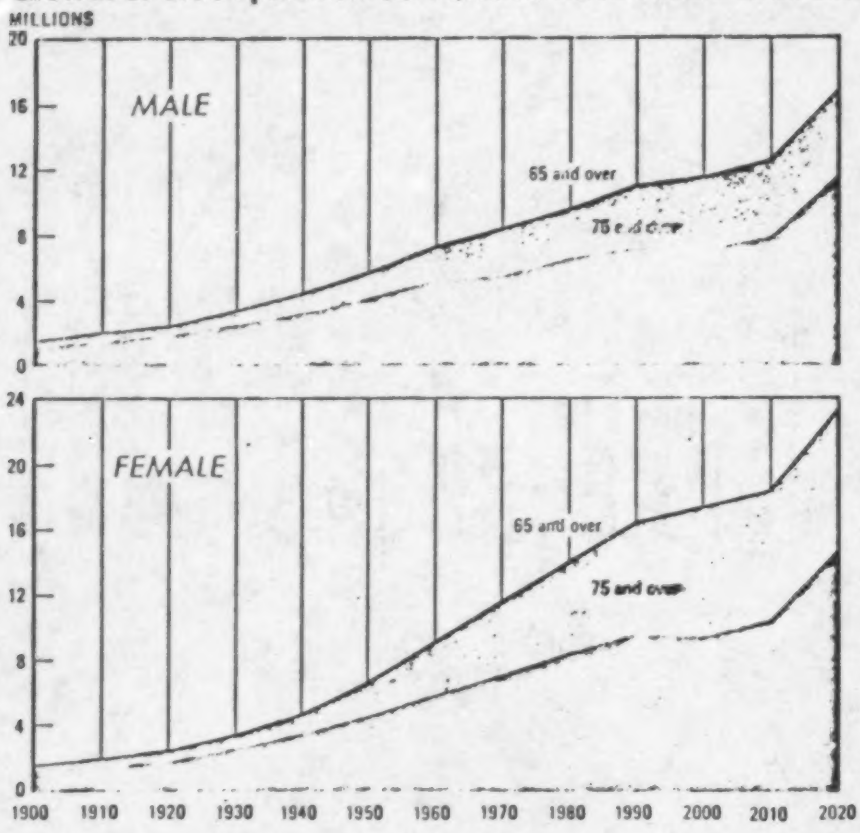
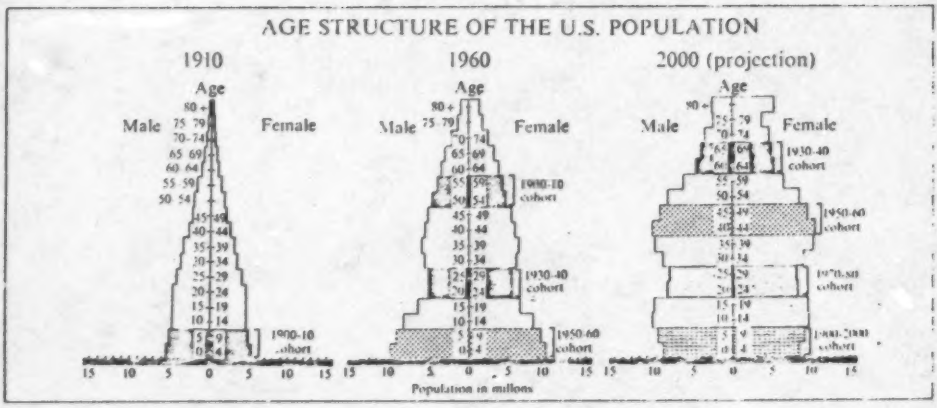


FIGURE 7


AGE STRUCTURE OF THE U.S. POPULATION
1910
1960
2000 (projection)
Age
Male
Female
1900-10 cohort
1930-40 cohort
1950-60 cohort
Population in millions

STATEMENT OF

WILLIAM G. POORTVLIET

METROPOLITAN LIFE INSURANCE COMPANY

ON

LIFE EXPECTANCY TRENDS

BEFORE THE

SUBCOMMITTEE ON SAVINGS, PENSIONS & INVESTMENT POLICY

COMMITTEE ON FINANCE

JULY 15, 1983

Re: Trends in Life Expectancy

The purpose of this statement is to provide a brief overview of the matter of longevity among the people in the United States. Past trends as well as expected future trends in longevity are discussed. Also, presented are the potential gains which could follow the elimination of major diseases as well as the possible consequences in terms of the likely proportion of the elderly in the population in the future.

At the outset, it will be helpful if we define some of the terminology.

Definition of Life Expectancy

In order to avoid confusion, it is important to recognize the difference between the concept of life expectancy and the concept of the average age at death.

The life expectancy at any age is the average number of years remaining to be lived by those who have already reached that age; the number of years is determined from an array of age-specific mortality rates.

The average age at death for people at a given age is merely the sum of that age plus the life expectancy at that age. For example, based on 1982 population data the life expectancy of persons aged 65 is 16.8 years. Accordingly, the average age at death is 65 plus 16.8 or 81.8. When viewed in this way, it can be seen that it is only the mortality rates beyond age 65 that affect the life expectancy beyond age 65. On the other hand, the life expectancy at birth is 74.5 based on 1982 data.

From the foregoing it can be seen that medical advances affecting primarily the adult population can serve to improve the life expectancy for adults as well as for newborns. Improvements in infant mortality will increase the life expectancy at birth, but will not initially affect the longevity of those already age 65.

Trend of Life Expectancy

Given these definitions, we can now briefly discuss recent trends. Drawing from the detailed data set forth in Tables 1-3 attached hereto, life expectancy at birth for the total population of the United States has increased from 47.3 years in 1900 to an estimated 74.5 years in 1982. This is a record high. For men the corresponding increase has been from 46.3 years to 70.7 years while for women it has been from 48.3 years to 78.2 years. Improvement in future life expectancy has also occurred for the older ages but at a slower rate than the expectancy at birth. For those reaching age 65, life expectancy has risen from 11.9 years in 1900-1902 to 16.8 years in 1982; for those age 75, the corresponding increase has been from 7.1 years to 10.8 years. For those age 85, the increase has been from 4.0 years in 1900-1902 to 6.2 years in 1982. As of 1982, a man age 65 could expect to live 14.5 additional years and a woman 18.8 additional years; for age 75, the expectancies are 9.1 years and 11.9 years respectively. At age 85, male life expectancy in 1982 is 5.2 years and that for females is 6.7 years.

It is possible to generalize with respect to these increases in longevity. Improvements in public health, medical advances, and particularly the sharp reduction in deaths from infectious diseases were largely responsible for the rise in life expectancy in the first half of the century, particularly among the young and middle aged. More recently, lower death rates from the chronic diseases, particularly heart disease, played an important role.

Projections of Life Expectancy

The Social Security Administration periodically publishes projections of life tables for the United States population. Currently, Actuarial Study No. 87 presents projections of life expectancy to the year 2050 for men and women, separately. Following are comments on some of the data available to us in that study, which is summarized in Table 3 attached.

For men, life expectancy at birth is projected to rise gradually from the current level of 70.7 years to 75.8 years in the year 2050. For women, the expectancy would be from the current level of 78.2 years to 83.8 years in 2050.

At age 65 the projected life expectancy for males is expected to increase from the current level of 14.5 years to 17.6 years in 2050 and for females from 18.8 years to 23.1 years in 2050.

At age 75, the projected life expectancy for males is expected to increase from the current level of 9.1 years to 11.6 years in 2050 and for females from the current level of 11.9 years to 15.8 years in 2050.

These projections would vary depending upon assumptions as to the development of new diagnostic and surgical techniques, the presence of environmental pollutants, nutritional advances, incidence of violence, prevalence of smoking, misuse of drugs, life style, and other similar factors.

Potential Gains in Longevity Due to Elimination of Specified Causes of Death

As might be expected, life expectancy could be substantially increased in the event of a major breakthrough in medical research such as the discovery of a cure for cancer or the elimination of heart disease.

In order to gain insight in this regard, it is helpful to make some hypothetical calculations. Referring to attached Tables 4(a) and 4(b), which are based on 1969-71 mortality data, the complete elimination of heart disease could add almost 6 years to the life expectancy at birth. For those age 65 the gain could be 5.1 years, at age 75 the gain could be 4.2 years. There would be an expected increase in life expectancy of 3.1 years at age 85.

Similarly, a cure for malignant neoplasms could cause a rise in life expectancy at birth of 2.3 years; the increase would be 1.4 years at age 65, 0.8 years at age 75, and 0.3 years at age 85.

The elimination of cerebrovasculer diseases (stroke) would add about 1 year of life across the age spectrum; the gain from the elimination of other causes of death would be smaller.

Population Trends

Increases in life expectancy and the aging of the "baby-boom" generation will almost certainly lead to a greater proportion of the elderly in the population. The attached Table 5 illustrates that the proportion of persons 65 and older is projected to rise from 12.0 percent in 1985 to 13.1 percent in 2000, reaching 21.7 percent by 2050. The proportion of persons age 75 and over is projected to rise from 4.9 percent in 1985, to 12 percent in 2050.

All projections indicate there will be a sharp rise in those age 85 and older, with the proportion rising from 1.2 percent in 1985, to 5.2 percent in 2050.

The "Aged Dependency Ratio"

This measure has special significance and is defined as the ratio of the number of persons aged 65 and over to the number of persons aged 20 to 64.

Actuarial Study No. 85 entitled "Social Security Area Population Projections, 1981" presents tables showing projections of these dependency ratios based upon various mortality and fertility assumptions. Using intermediate mortality and fertility assumptions, the aged dependency ratio is projected to almost double from .20 in 1985 to .39 in 2035 and more or less level off thereafter. An increase in the aged dependency ratio is almost certain to occur after the turn of the century because large numbers of persons in the baby-boom generation retire at that time while a smaller

number of persons are expected to be in the work force helping with needed support. Of course, increasing the retirement age could ease some of the problems which this increasing ratio could present.

Consequences of Increased Population at the Older Ages

The economic, medical, psychological, and social needs of increasing numbers of elderly persons are obviously an important and growing matter of concern to all of us throughout the nation. The special problems of the Social Security system, and particularly the Medicare program are among the matters requiring special attention.

As part of our continuing interest in these vital matters, Metropolitan regularly does studies concerning the characteristics of the aged, drawing upon Census data as well as other sources of population and mortality data. We will, of course, be pleased to furnish any data or studies which are available to us at any time - and to any extent - that may be helpful to the Committee. Furthermore, we are available to discuss these and other similar studies with the Committee at its convenience.

Respectfully submitted,

William G. Poortvliet
Senior Vice President & Chief Actuary
Metropolitan Life Insurance Company
One Madison Avenue
New York, NY 10010

TABLE 1—LIFE EXPECTANCY AT BIRTH IN YEARS, UNITED STATES, 1900–1978

Area and year	Total			White			All other		
	Both sexes	Male	Female	Both sexes	Male	Female	Both sexes	Male	Female
UNITED STATES									
1900[1]	49.2	48.2	51.1	50.9	48.2	51.8	33.0	32.5	33.5
1901[1]	49.4	48.4	51.3	51.1	48.4	52.0	33.3	32.8	33.8
1902[1]	49.8	48.8	51.7	51.4	48.8	52.3	33.8	33.3	34.3
1903[1]	50.2	49.2	52.1	51.8	49.2	52.7	34.3	33.8	34.8
1904[1]	50.6	49.6	52.5	52.2	49.6	53.2	34.9	34.4	35.4
1905[1]	50.9	49.8	52.8	52.5	49.8	53.5	35.0	34.5	35.5
1906[1]	51.1	50.0	53.0	52.7	50.0	53.7	35.2	34.7	35.7
1907[1]	51.3	50.2	53.2	52.9	50.2	53.9	35.4	34.9	35.9
1908[1]	51.5	50.4	53.4	53.1	50.4	54.1	35.6	35.1	36.1
1909[1]	51.7	50.6	53.6	53.3	50.6	54.3	35.8	35.3	36.3
1910[1]	51.8	50.7	53.7	53.4	50.7	54.4	35.9	35.4	36.4
1911[1]	51.9	50.8	53.8	53.5	50.8	54.5	36.0	35.5	36.5
1912[1]	52.0	50.9	53.9	53.6	50.9	54.6	36.1	35.6	36.6
1913[1]	52.1	51.0	54.0	53.7	51.0	54.7	36.2	35.7	36.7
1914[1]	52.2	51.1	54.1	53.8	51.1	54.8	36.3	35.8	36.8
1915[1]	52.3	51.2	54.2	53.9	51.2	54.9	36.4	35.9	36.9
1916[1]	52.4	51.3	54.3	54.0	51.3	55.0	36.5	36.0	37.0
1917[1]	52.5	51.4	54.4	54.1	51.4	55.1	36.6	36.1	37.1
1918[1]	52.6	51.5	54.5	54.2	51.5	55.2	36.7	36.2	37.2
1919[1]	52.7	51.6	54.6	54.3	51.6	55.3	36.8	36.3	37.3
1920[1]	52.8	51.7	54.7	54.4	51.7	55.4	36.9	36.4	37.4
1921[1]	52.9	51.8	54.8	54.5	51.8	55.5	37.0	36.5	37.5
1922[1]	53.0	51.9	54.9	54.6	51.9	55.6	37.1	36.6	37.6
1923[1]	53.1	52.0	55.0	54.7	52.0	55.7	37.2	36.7	37.7
1924[1]	53.2	52.1	55.1	54.8	52.1	55.8	37.3	36.8	37.8
1925[1]	53.3	52.2	55.2	54.9	52.2	55.9	37.4	36.9	37.9
1926[1]	53.4	52.3	55.3	55.0	52.3	56.0	37.5	37.0	38.0
1927[1]	53.5	52.4	55.4	55.1	52.4	56.1	37.6	37.1	38.1
1928[1]	53.6	52.5	55.5	55.2	52.5	56.2	37.7	37.2	38.2
1929[1]	53.7	52.6	55.6	55.3	52.6	56.3	37.8	37.3	38.3
1930[1]	59.7	58.1	61.6	59.9	58.1	61.7	48.1	46.5	49.9
1931[1]	59.4	57.9	61.4	59.6	57.9	61.5	47.8	46.3	49.6
1932[1]	59.0	57.6	61.0	59.2	57.6	61.1	47.5	46.0	49.3
1933[1]	59.7	58.2	61.7	59.9	58.2	61.8	48.2	46.6	50.0
1934[1]	59.9	58.4	61.9	60.1	58.4	62.0	48.4	46.8	50.2
1935[1]	59.7	58.2	61.7	59.9	58.2	61.8	48.2	46.6	50.0
1936[1]	60.6	59.1	62.6	60.8	59.1	62.7	49.1	47.5	50.9
1937[1]	61.0	59.5	63.0	61.2	59.5	63.1	49.5	47.9	51.3
1938[1]	60.8	59.3	62.8	61.0	59.3	62.9	49.3	47.7	51.1
1939[1]	61.4	59.9	63.4	61.6	59.9	63.5	49.9	48.3	51.7
1940[1]	62.1	60.8	63.9	62.3	60.8	64.0	50.8	49.0	52.4
1941[1]	62.8	61.4	64.5	63.0	61.4	64.6	51.4	49.6	53.0
1942[1]	63.4	62.0	65.1	63.6	62.0	65.2	52.0	50.2	53.6
1943[1]	63.9	62.5	65.6	64.1	62.5	65.7	52.5	50.7	54.1
1944[1]	64.4	63.0	66.1	64.6	63.0	66.2	53.0	51.2	54.6
1945[1]	64.4	63.0	66.2	64.6	63.0	66.2	53.0	51.2	54.6
1946[1]	65.3	63.9	67.1	65.5	63.9	67.1	53.9	52.1	55.5
1947[1]	65.5	64.1	67.3	65.7	64.1	67.3	54.1	52.3	55.7
1948[1]	65.6	64.2	67.4	65.8	64.2	67.4	54.2	52.4	55.8
1949[1]	65.9	64.4	67.7	66.1	64.4	67.7	54.4	52.6	56.1
1950[1]	68.2	65.6	71.1	68.4	65.6	71.0	57.0	54.1	59.1
1951[1]	68.6	65.9	71.4	68.8	65.9	71.4	57.4	54.4	59.4
1952[1]	68.7	66.0	71.5	68.9	66.0	71.5	57.5	54.5	59.5
1953[1]	68.8	66.1	71.6	69.0	66.1	71.6	57.6	54.6	59.6
1954[1]	69.2	66.5	72.0	69.4	66.5	72.0	58.0	55.0	60.0
1955[1]	69.4	66.7	72.2	69.6	66.7	72.2	58.2	55.2	60.2
1956[1]	69.6	66.9	72.4	69.8	66.9	72.4	58.4	55.4	60.4
1957[1]	69.3	66.6	72.1	69.5	66.6	72.1	58.1	55.1	60.1
1958[1]	69.3	66.6	72.1	69.5	66.6	72.1	58.1	55.1	60.1
1959[1]	69.6	66.8	72.4	69.8	66.8	72.4	58.4	55.4	60.4
1960[1]	69.7	66.8	72.6	69.9	66.8	72.6	58.5	55.4	60.6
1961[1]	70.1	67.2	72.9	70.3	67.2	72.9	58.9	55.8	60.9
1962[1]	70.1	67.2	72.9	70.3	67.2	72.9	58.9	55.8	60.9
1963[1]	70.2	67.3	73.1	70.4	67.3	73.1	59.0	55.9	61.1
1964[1]	70.5	67.6	73.3	70.7	67.6	73.3	59.3	56.2	61.3
1965[1]	70.2	67.2	73.1	70.4	67.2	73.1	58.9	55.8	61.1
1966[1]	70.4	67.4	73.3	70.6	67.4	73.3	59.1	56.0	61.3
1967[1]	70.7	67.8	73.6	70.9	67.8	73.6	59.5	56.4	61.6
1968[1]	70.2	67.1	73.4	70.4	67.1	73.4	58.8	55.7	61.4
1969[1]	70.5	67.4	73.7	70.7	67.4	73.7	59.1	56.0	61.7
1970[1]	70.9	67.9	74.0	71.1	67.9	74.0	59.6	56.5	62.0
1971[1]	71.3	68.3	74.4	71.5	68.3	74.4	60.0	56.9	62.4
1972[1]	71.4	68.4	74.5	71.6	68.4	74.5	60.1	57.0	62.5
1973[1]	71.9	68.9	75.0	72.1	68.9	75.0	60.6	57.5	63.0
1974[1]	72.4	69.4	75.5	72.6	69.4	75.5	61.1	58.0	63.5
1975[1]	72.6	69.6	75.8	72.8	69.6	75.8	61.3	58.2	63.8
1976[1]	72.9	69.9	76.0	73.1	69.9	76.0	61.6	58.5	64.0
1977[1]	73.2	70.2	76.3	73.4	70.2	76.3	61.9	58.8	64.3
1978[1]	73.4	70.4	76.5	73.6	70.4	76.5	62.1	59.0	64.5
DEATH REGISTRATION STATES									
1900[2]	49.2	48.2	51.1	50.9	48.2	51.8	33.0	32.5	33.5
1901[2]	49.4	48.4	51.3	51.1	48.4	52.0	33.3	32.8	33.8
1902[2]	49.8	48.8	51.7	51.4	48.8	52.3	33.8	33.3	34.3
1903[2]	50.2	49.2	52.1	51.8	49.2	52.7	34.3	33.8	34.8
1904[2]	50.6	49.6	52.5	52.2	49.6	53.2	34.9	34.4	35.4
1905[2]	50.9	49.8	52.8	52.5	49.8	53.5	35.0	34.5	35.5
1906[2]	51.1	50.0	53.0	52.7	50.0	53.7	35.2	34.7	35.7
1907[2]	51.3	50.2	53.2	52.9	50.2	53.9	35.4	34.9	35.9
1908[2]	51.5	50.4	53.4	53.1	50.4	54.1	35.6	35.1	36.1
1909[2]	51.7	50.6	53.6	53.3	50.6	54.3	35.8	35.3	36.3
1910[2]	51.8	50.7	53.7	53.4	50.7	54.4	35.9	35.4	36.4
1911[2]	51.9	50.8	53.8	53.5	50.8	54.5	36.0	35.5	36.5
1912[2]	52.0	50.9	53.9	53.6	50.9	54.6	36.1	35.6	36.6
1913[2]	52.1	51.0	54.0	53.7	51.0	54.7	36.2	35.7	36.7
1914[2]	52.2	51.1	54.1	53.8	51.1	54.8	36.3	35.8	36.8
1915[2]	52.3	51.2	54.2	53.9	51.2	54.9	36.4	35.9	36.9
1916[2]	52.4	51.3	54.3	54.0	51.3	55.0	36.5	36.0	37.0
1917[2]	52.5	51.4	54.4	54.1	51.4	55.1	36.6	36.1	37.1
1918[2]	52.6	51.5	54.5	54.2	51.5	55.2	36.7	36.2	37.2
1919[2]	52.7	51.6	54.6	54.3	51.6	55.3	36.8	36.3	37.3
1920[2]	52.8	51.7	54.7	54.4	51.7	55.4	36.9	36.4	37.4
1921[2]	52.9	51.8	54.8	54.5	51.8	55.5	37.0	36.5	37.5
1922[2]	53.0	51.9	54.9	54.6	51.9	55.6	37.1	36.6	37.6
1923[2]	53.1	52.0	55.0	54.7	52.0	55.7	37.2	36.7	37.7
1924[2]	53.2	52.1	55.1	54.8	52.1	55.8	37.3	36.8	37.8
1925[2]	53.3	52.2	55.2	54.9	52.2	55.9	37.4	36.9	37.9
1926[2]	53.4	52.3	55.3	55.0	52.3	56.0	37.5	37.0	38.0
1927[2]	53.5	52.4	55.4	55.1	52.4	56.1	37.6	37.1	38.1
1928[2]	53.6	52.5	55.5	55.2	52.5	56.2	37.7	37.2	38.2
1929[2]	53.7	52.6	55.6	55.3	52.6	56.3	37.8	37.3	38.3
1930[2]	59.7	58.1	61.6	59.9	58.1	61.7	48.1	46.5	49.9
1931[2]	59.4	57.9	61.4	59.6	57.9	61.5	47.8	46.3	49.6
1932[2]	59.0	57.6	61.0	59.2	57.6	61.1	47.5	46.0	49.3
1933[2]	59.7	58.2	61.7	59.9	58.2	61.8	48.2	46.6	50.0
1934[2]	59.9	58.4	61.9	60.1	58.4	62.0	48.4	46.8	50.2
1935[2]	59.7	58.2	61.7	59.9	58.2	61.8	48.2	46.6	50.0
1936[2]	60.6	59.1	62.6	60.8	59.1	62.7	49.1	47.5	50.9
1937[2]	61.0	59.5	63.0	61.2	59.5	63.1	49.5	47.9	51.3
1938[2]	60.8	59.3	62.8	61.0	59.3	62.9	49.3	47.7	51.1
1939[2]	61.4	59.9	63.4	61.6	59.9	63.5	49.9	48.3	51.7
1940[2]	62.1	60.8	63.9	62.3	60.8	64.0	50.8	49.0	52.4
1941[2]	62.8	61.4	64.5	63.0	61.4	64.6	51.4	49.6	53.0
1942[2]	63.4	62.0	65.1	63.6	62.0	65.2	52.0	50.2	53.6
1943[2]	63.9	62.5	65.6	64.1	62.5	65.7	52.5	50.7	54.1
1944[2]	64.4	63.0	66.1	64.6	63.0	66.2	53.0	51.2	54.6
1945[2]	64.4	63.0	66.2	64.6	63.0	66.2	53.0	51.2	54.6
1946[2]	65.3	63.9	67.1	65.5	63.9	67.1	53.9	52.1	55.5
1947[2]	65.5	64.1	67.3	65.7	64.1	67.3	54.1	52.3	55.7
1948[2]	65.6	64.2	67.4	65.8	64.2	67.4	54.2	52.4	55.8
1949[2]	65.9	64.4	67.7	66.1	64.4	67.7	54.4	52.6	56.1
1950[2]	68.2	65.6	71.1	68.4	65.6	71.0	57.0	54.1	59.1
1951[2]	68.6	65.9	71.4	68.8	65.9	71.4	57.4	54.4	59.4
1952[2]	68.7	66.0	71.5	68.9	66.0	71.5	57.5	54.5	59.5
1953[2]	68.8	66.1	71.6	69.0	66.1	71.6	57.6	54.6	59.6
1954[2]	69.2	66.5	72.0	69.4	66.5	72.0	58.0	55.0	60.0
1955[2]	69.4	66.7	72.2	69.6	66.7	72.2	58.2	55.2	60.2
1956[2]	69.6	66.9	72.4	69.8	66.9	72.4	58.4	55.4	60.4
1957[2]	69.3	66.6	72.1	69.5	66.6	72.1	58.1	55.1	60.1
1958[2]	69.3	66.6	72.1	69.5	66.6	72.1	58.1	55.1	60.1
1959[2]	69.6	66.8	72.4	69.8	66.8	72.4	58.4	55.4	60.4
1960[2]	69.7	66.8	72.6	69.9	66.8	72.6	58.5	55.4	60.6
1961[2]	70.1	67.2	72.9	70.3	67.2	72.9	58.9	55.8	60.9
1962[2]	70.1	67.2	72.9	70.3	67.2	72.9	58.9	55.8	60.9
1963[2]	70.2	67.3	73.1	70.4	67.3	73.1	59.0	55.9	61.1
1964[2]	70.5	67.6	73.3	70.7	67.6	73.3	59.3	56.2	61.3
1965[2]	70.2	67.2	73.1	70.4	67.2	73.1	58.9	55.8	61.1
1966[2]	70.4	67.4	73.3	70.6	67.4	73.3	59.1	56.0	61.3
1967[2]	70.7	67.8	73.6	70.9	67.8	73.6	59.5	56.4	61.6
1968[2]	70.2	67.1	73.4	70.4	67.1	73.4	58.8	55.7	61.4
1969[2]	70.5	67.4	73.7	70.7	67.4	73.7	59.1	56.0	61.7
1970[2]	70.9	67.9	74.0	71.1	67.9	74.0	59.6	56.5	62.0
1971[2]	71.3	68.3	74.4	71.5	68.3	74.4	60.0	56.9	62.4
1972[2]	71.4	68.4	74.5	71.6	68.4	74.5	60.1	57.0	62.5
1973[2]	71.9	68.9	75.0	72.1	68.9	75.0	60.6	57.5	63.0
1974[2]	72.4	69.4	75.5	72.6	69.4	75.5	61.1	58.0	63.5
1975[2]	72.6	69.6	75.8	72.8	69.6	75.8	61.3	58.2	63.8
1976[2]	72.9	69.9	76.0	73.1	69.9	76.0	61.6	58.5	64.0
1977[2]	73.2	70.2	76.3	73.4	70.2	76.3	61.9	58.8	64.3
1978[2]	73.4	70.4	76.5	73.6	70.4	76.5	62.1	59.0	64.5

[1] Excludes deaths of nonresidents of the United States.
[2] Figures are revised, and therefore, may differ from those published in volumes of Vital Statistics of the United States, Vol. II, Mortality, Part A, for 1974 and earlier years.
[3] Figures based on a 50-percent sample.
[4] Figures by color exclude data for residents of New Jersey

Source: Vital Statistics of the United States 1978, Volume II-Section 5, Life Tables, p.5-16, 1980

TABLE 2—LIFE EXPECTANCY IN YEARS, UNITED STATES, 1900-1982

	Age in Years			
Years	0	65	75	85
1900-1902	49.2	11.9	7.1	4.0
1939-1941	63.6	12.8	7.6	4.3
1959-1961	69.9	14.4	8.7	4.6
1969-1971	70.8	15.0	9.3	5.3
1975	72.5	16.0	10.2	6.2
1980	73.8	16.5	10.4	5.9
1982	74.5	16.8	10.8	6.2

Source: Statistical Bureau, Metropolitan Life Insurance Company

TABLE 3—PROJECTIONS OF LIFE EXPECTANCY, UNITED STATES, 1982-2050

	Males				Females			
	Age in Years				Age in Years			
Year	0	65	75	85	0	65	75	85
1982*	70.7	14.5	9.1	5.2	78.2	18.8	11.9	6.7
1990+	72.3	15.1	9.6	5.6	79.9	19.9	12.9	7.2
2000+	73.4	15.7	10.1	6.0	81.1	20.8	13.8	7.8
2020+	74.4	16.5	10.7	6.5	82.2	21.7	14.6	8.4
2050+	75.8	17.6	11.6	7.2	83.8	23.1	15.8	9.4

*Statistical Bureau, Metropolitan Life Insurance Company
+Life Tables for the United States:1900-2050, Actuarial Study No. 87, Social Security Administration, 1982

TABLE 4a—GAIN IN LIFE EXPECTANCY DUE TO ELIMINATION OF SPECIFIED CAUSES OF DEATH FOR THE TOTAL POPULATION: UNITED STATES, 1969-71

Exact age in years	Gain in years in expectation of life at the indicated exact age due to elimination of the specified cause							
	Malignant neoplasms	Malignant neoplasms of digestive organs	Malignant neoplasms of respiratory system	Diabetes	Diseases of the heart	Ischemic heart disease	Acute myocardial infarction	Cerebrovascular disease
0	2.47	.60	.50	.24	5.86	5.06	2.43	1.19
1	2.52	.61	.51	.25	5.98	5.16	2.48	1.21
5	2.51	.61	.51	.24	5.99	5.17	2.48	1.21
10	2.49	.61	.51	.24	6.00	5.18	2.49	1.20
15	2.48	.62	.51	.24	6.01	5.20	2.49	1.21
20	2.47	.62	.51	.24	6.03	5.22	2.51	1.21
25	2.47	.63	.52	.25	6.07	5.27	2.53	1.22
30	2.45	.62	.52	.24	6.09	5.29	2.54	1.21
35	2.42	.62	.52	.23	6.11	5.31	2.54	1.21
40	2.36	.62	.52	.23	6.10	5.32	2.53	1.21
45	2.29	.61	.50	.23	6.04	5.28	2.45	1.20
50	2.15	.59	.47	.22	5.91	5.18	2.40	1.19
55	1.94	.55	.41	.21	5.71	5.01	2.25	1.17
60	1.68	.50	.34	.20	5.44	4.78	2.05	1.17
65	1.38	.43	.26	.18	5.08	4.47	1.79	1.15
70	1.06	.34	.17	.15	4.64	4.07	1.49	1.11
75	.78	.27	.10	.12	4.15	3.64	1.16	1.05
80	.51	.18	.05	.08	3.62	3.14	.86	.93
85	.31	.12	.03	.05	3.09	2.66	.61	.79

Source: U.S. Decennial Life Tables for 1969-71, Vol. 1, No. 5, United States Life Tables by Causes of Death: 1969-71, pp. 5-58 - 5-59, 1975

TABLE 4b—GAIN IN LIFE EXPECTANCY DUE TO ELIMINATION OF SPECIFIED CAUSES OF DEATH FOR THE TOTAL POPULATION: UNITED STATES, 1969-71

Exact age in years	Gain in years in expectation of life at the indicated exact age due to elimination of the specified cause—Con.						
	Arterio-sclerosis	Diseases of respiratory system	Influenza and pneumonia	Bronchitis, emphysema, and asthma	Cirrhosis of liver	Motor vehicle accidents	All other accidents
1	.15	.83	.47	.20	.26	.70	.63
5	.14	.69	.36	.20	.39	.71	.60
10	.13	.66	.35	.19	.28	.67	.54
15	.13	.65	.33	.19	.28	.64	.51
20	.13	.65	.32	.19	.29	.61	.44
25	.14	.64	.32	.19	.29	.46	.41
30	.14	.64	.32	.20	.29	.34	.38
35	.14	.63	.31	.19	.28	.28	.33
40	.14	.62	.30	.19	.27	.22	.29
45	.14	.61	.30	.19	.25	.16	.26
50	.15	.60	.29	.19	.22	.15	.23
55	.15	.58	.28	.19	.17	.12	.19
60	.15	.55	.26	.18	.13	.09	.16
65	.16	.52	.26	.17	.09	.07	.13
70	.17	.47	.25	.15	.06	.06	.13
75	.17	.41	.23	.11	.03	.02	.11
80	.19	.36	.23	.06	.02	.03	.10
85	.20	.29	.20	.04	.00	.01	.09
	.21	.25	.20	.03	.01	.01	.09

Source: U.S. Decennial Life Tables for 1969-71, Vol. 1, No. 5, United States Life Tables by Causes of Death: 1969-71, pp. 5-58 - 5-59, 1975

TABLE 5—PROJECTIONS OF POPULATION, UNITED STATES, 1985-2050

Ages 55 and Over

Year	Ages 55 and Over		Ages 65 and Over		Ages 75 and Over		Ages 85 and Over	
	Population in 1000s	Percent of Total Population	Population in 1000s	Percent of Total Population	Population in 1000s	Percent of Total Population	Population in 1000s	Percent of Total Population
1985	50,879	21.3	28,673	12.0	11,810	4.9	2,794	1.2
1990	52,889	21.2	31,799	12.7	13,745	5.5	3,461	1.4
1995	54,957	21.2	34,006	13.1	15,483	6.0	4,255	1.6
2000	58,815	21.9	35,036	13.1	17,343	6.5	5,136	1.9
2025	96,190	32.0	58,636	19.5	25,548	8.5	7,678	2.6
2050	104,337	33.8	67,060	21.7	37,039	12.0	16,063	5.2

Source: Population Estimates and Projections - 1982-2050, Bureau of the Census